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AIRPORTS OF MOZAMBIQUE

FEASIBILITY STUDY FOR THE EXPANSION AND MODERNIZATION OF PEMBA OR NACALA AIRPORT

For

AEROPORTOS de MOÇAMBIQUE
AV. ACORDOS de LUSAKA, NO 3267
MAPUTO, MOZAMBIQUE

FINAL REPORT

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Submitted by
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EXECUTIVE SUMMARY

Introduction

Context

Aeroportos de Mozambique (ADM), as an autonomous and financially independent state company under the tutelage of the Ministry of Transportation and Communications, has a broad mandate to support economic development and tourism throughout the country. This includes the northern coastal region where the Government has received demands from communities for improvements in the capacity of airports to accommodate a wider range of air services.

Various considerations for airport development in the northern coastal region have been put forth by successive governments, but no definitive long-term strategy for implementation has been decided. According to its mandate, ADM needs to proceed with a strategic planning process aimed at identifying an investment plan that responds to the needs of the region. The increased demand in the tourism sector due to interest in wildlife reserves and beach resorts on the coast; and the increase in mining and commercial activity in the northern part of the country, give the development of improved airport capacity for the region a high priority for ADM.

ADM and representatives of the social and economic stakeholders in the northern coastal area and have identified two logical sites for the development of airport facilities to serve an expanded tourist market by accommodating long-range (inter-continental) flights according to two options: (a) large-scale expansion of the existing airport at Pemba and (b) conversion of the existing air force base at Nacala to civilian use.

The cities of Pemba and Nacala are located along the Mozambican coast of the Indian Ocean, approximately 815 km and 765 km respectively north of the capital city, Maputo. In addition to their importance as centers of administration and trade for their respective regions, both serve as essential gateways to natural and cultural tourist resources of great potential.

Infrastructure development is one of the key priorities of the government at the national level and Mozambique is supporting several other infrastructure projects in the Nacala Corridor (a vast area linked to the Port of Nacala and extending into several neighboring land-locked countries), including a private railroad initiative carried out by US investors. Local and international private investors have also indicated interest in the development of improved airport facilities in the northern area of Mozambique to better serve the resort zones of the Indian Ocean coastal area from Nacala to Pemba. The following options were points of discussion:

- **Pemba Airport**: Pemba airport is a regional airport operated by ADM. European carriers have requested to be allowed the operation of wide-body aircraft three times a week at Pemba and LAM. The national airline confirmed that it would schedule direct flights from several European capitals to Pemba if adequate facilities were in place. The existing facilities; however, do not have the capacity to accommodate this demand and the rapid growth in passenger traffic volume requires a programmed response to provide an adequate level of service. The existing 1,800 m runway does not allow the operation of wide-body aircraft on long-range flights.

- **Nacala Airport:** Nacala airfield is part of a military base currently managed by the Mozambique Air Force and provides very limited and occasional non-commercial air service. However, it is extremely well-located and well equipped with a 2,500 m runway. If converted to civil operation, it would provide direct access to air transport for a region which is currently served by the inland airport some three hours away at the regional capital, Nampula. Although immediate development of Nacala as a civil airport may be favorable from a commercial and tourism perspective, ADM may face possible regulatory barriers in transferring the management of this airport facility. Also, since the facilities at Nacala were not designed for commercial traffic, conversion to civil use would require the construction of air navigational aids, a new passenger terminal and cargo facilities, among others.

USTDA

ADM has obtained a grant from the US Trade and Development Agency and has selected AAROTEC Infrastructure Group under this grant to undertake the present Feasibility Study for the Expansion and Modernization of Pemba or Nacala Airport. The objective of the study is to assist ADM in determining the requirements, feasibility and relative priority of expanding and upgrading one of the two airports (either Pemba or Nacala) and the impact of that possible expansion on other airports operated by ADM.

The Terms of Reference of the present study were drafted in order to facilitate the investment decision-making process on the part of ADM; thereby, enabling the organization to take measures to mobilize the necessary financing and to develop plans and other strategic measures on the basis of an informed analysis. It is intended to assist ADM in attracting interest in the project and arranging the requisite financial support for its implementation. As such, the study will help ADM to fulfill its mandate of improving the airport system infrastructure so that it will play an integral role in developing, growing and further stabilizing the economy of Mozambique.

Objectives and Scope

The present feasibility study is intended to improve a key component of the aviation sector in Mozambique and contribute to the general development of the country's infrastructure, not only in aviation, but in other transportation related activities. This feasibility study constitutes the starting point for the planning and sizing of airport

facilities and the assessment of environmental social and economic impacts. It is intended to provide critical information to perform technical, financial, and economic assessments of the airports and constitute a basis for investment decisions. The stated objectives of the present Study are as follows:

- Examine potential growth at Pemba, Nacala and other airports in Mozambique;
- Establish the viability of converting the Nacala Military Base into a commercial international airport, including the viability of transferring control of the facilities to be used for civilian purposes to ADM;
- Recommend the expansion of either Pemba or Nacala in the northern region of the country, based on an analysis of projected traffic growth and technical and financial requirements;
- Assess the potential financial impacts on Vilankulos airport associated with the development of one airport in the northern region (either Pemba or Nacala);
- Develop a twenty-year investment program for the recommended airport (Pemba or Nacala);

Approach

AAROTEC's approach in conducting and managing the work on this project was based on providing a specialized team of international experts working closely with ADM personnel.

- AAROTEC experts inspected and assessed the existing facilities and conducted interviews with operators at both airports in order to determine their condition and adequacy to handle present and future traffic.

- The historical records and existing forecasts of annual airport activities were reviewed, analyzed and organized by AAROTEC,

- Site visits and meetings with Government and Airport Authority officials, airlines, tourism operators, etc. were held to discuss the relevance of the existing facilities and the proposed developments which may have an impact on the future evolution of air traffic in Mozambique.

- Forecasts of air passengers, air cargo and aircraft movements were prepared taking into account the likely impact of the proposed development of new airport facilities; the forecasts were organized according to international, regional and domestic sectors: and included estimations of annual and peak period planning parameters for passengers, aircraft movements and air cargo.

- The legal issues associated with the possible transfer of airport facilities at the Nacala military base to civilian administration were analyzed in the light of the current Mozambican legislation and regulations.

- A preliminary financial comparison was made of corresponding development programs to accommodate long-range international airline service at both Pemba and Nacala.

- A demand/capacity analysis was carried out on the basis of the above-mentioned air traffic forecasts and the existing airport infrastructure in order to determine the facility requirements on the basis of ICAO Standards and Recommended Practices (SARPs), the methodologies described in the IATA Airport Development Reference Manual and FAA guidelines.

- A conceptual development plan was prepared for the selected airport development program, taking into account the above-mentioned facility requirements and the existing site conditions.

- AutoCAD drawings of the conceptual development were prepared to illustrate the conceptual development plan.

- The capital costs associated with the implementation of this program were estimated.

- A detailed financial analysis was prepared to determine the feasibility of the proposed development program for Nacala airport, using computer-generated financial projection models.

- The impact of the proposed project on the environment was prepared taking into account both Malian legislation and World Bank guidelines.

- An assessment was made of the likely development impacts of the project, which was prepared using standard World Bank methodology.

Existing and Planned Airports Infrastructure

Pemba

The airport site is located on the west side of Pemba peninsula and approximately 3 km to the southeast of the city of Pemba. The airport is situated on a plateau approximately 100 m above sea level, which drops off steeply to the immediate north and the west of the airport facilities. The figures on the following page indicate the location of the airport in relation to its surroundings.

The development of Pemba airport to accommodate long-haul flights would require a significant expansion of the existing facilities. In particular, the existing main runway (1,800 m) does not allow the operation of the proposed wide-body aircraft and the passenger terminal (1,100 m^2) has already exceeded its capacity under the present passenger traffic. In addition, the airfield pavements require immediate attention, since they are deteriorating rapidly.

Pemba Airport

Pemba Airport Surroundings

The following were identified in the USTDA Definitional Mission Report as urgent investments required at Pemba in order to be able to accommodate long-range international flights. During the site visit to Pemba Airport, AAROTEC reviewed the

existing conditions and concurs with the recommendations of the USTDA Definitional Mission Report.

- Extension of the runway and taxiway;
- Resurfacing and reinforcement of the existing runway, taxiways and shoulders;
- Replacement and installation of a modern airfield lighting system;
- Possible implementation of an engineered materials arrestor system (EMAS) at the end of the security zone of the runway threshold;
- Expansion of the aircraft parking area;
- Expansion and modernization of the passenger terminal;
- Construction of a cargo area;
- Expansion of the fuel service area;
- Implementation of modern navigational aids;
- Upgrading of the fire rescue station including new equipment.

Airside Infrastructure

The existing infrastructure at Pemba airport is summarized in the following table.

Pemba Airport Existing Airside Infrastructure	
Coordinates	S 12:59.0; E 40:31.0
Elevation	101 m above sea level
Reference temperature	31.3 degrees Celsius
Runway #1	Main runway
ICAO Code	4C
Orientation	17/35
Dimensions	1,800 m x 45 m
Slope	0.2%
Surface	Asphalt
Surface conditions	Disintegration, construction joint depressions, pot-holes, edge erosion
Strength	PCN 24 F/A/X/U
Shoulders	No
Lighting	Yes
Taxiway	Perpendicular access taxiway
Dimensions	175 m x 23 m
Surface	Asphalt
Surface conditions	Disintegration, edge erosion
Shoulders	No
Lighting	Yes
Runway #2	Crosswind (secondary) runway)
Code	2B
Orientation	08/26
Dimensions	800 m x 45 m
Slope	NA
Surface	Asphalt
Surface conditions	Loose aggregate, pot holes, depressions
Strength	NA
Shoulders	No
Lighting	No
Commercial Apron	

Dimensions	80 m x 210 m
Surface	Asphalt
Surface conditions	Depressions, disintegration, oil spills
Shoulders	No
Lighting	Yes

The main runway 17/35 at Pemba Airport has no parallel taxiway. The geometry of the existing simple runway system presents no operating problems under present traffic levels. In the future, if needed, a taxiway loop at the south end of the runway would allow for more efficient aircraft operations.

Landside

The existing terminal building has a total floor area of approximately 1,100 m^2 and is in good operating condition. The passenger processing areas are all on the ground floor, with arrivals and departures situated side by side. The building also contains offices for the airport administration, the aeronautical information services, airlines and other users on both the ground floor and a partial upper level. The building is surmounted by a control tower and cab.

Aircraft fuel is available from two suppliers. The Petromoc facility consists of two above-ground tanks for Jet A-1 with a capacity of 25,000 l each, protected by bermed dyke, and a small office. The BP facility consists of two underground tanks for Jet A-1 with a capacity of 22,730 l each and one above-ground tank for Avgas with a capacity of 20,000 l, all protected by a dyke, as well as a small office. Both facilities appear to be modern, clean and well maintained.

The electrical sub-station contains a step-down transformer, an emergency power generator and constant current regulators dating back 15 years. According to the airport administration, the runway lighting cables are not in ideal condition due to problems with the insulation and consequent increased resistance.

The airport is equipped with one fire-fighting vehicle, with a capacity of 6000 l of water and 800 l of foam and an ambulance. The fire hall is located adjacent to and directly north of the passenger terminal building, facing the aircraft parking apron.

Other airport facilities include a small air cargo warehouse located to the north of the passenger terminal complex, two general aviation hangars located at the southern end of the landside complex, a small meteorological station (in rather poor condition) and car rental boutiques located along the landside access road.

Although the dimensions of the existing landside road system do not impose constraints for the management and flow vehicular of current traffic volumes, the access roads and vehicular parking areas need re-paving.

Operating Performance and Constraints

The site visit inspection indicated that extension of Pemba's main runway to the north is not feasible because there is a steep drop in the elevation of the natural terrain of almost a hundred meters. However, to the south the airport site is relatively flatter and leaves room for limited extension of the runway.

Although, Pemba airport requires expansion to be able to continue to serve air passengers traveling to/from the area, the AAROTEC Team feels that the proposed development of the facilities should be phased to coincide with the future growth and demand in order to avoid expensive over-building. The construction phasing should be decided as a function of the phasing of the required development to accommodate confirmed demand. Additionally, the airport site is severely limited because the surrounding topography drops off steeply at the west side of the airfield and at the north runway end; therefore, the constraints on the ultimate design of the airport at this site should be carefully considered before a tremendous investment is made at the present site. The appropriate ultimate design capacity may thus be limited by the site constraints.

Nacala

Nacala airfield is currently managed by the Air Force and provides very limited accommodation for general aviation service. The facilities at Nacala were not designed for commercial use; there is no passenger terminal, cargo facility, operational control tower or other airport support installations. This being said, the runway system (including taxiways) is 2,500 m long and sufficient for departures of a range of long-haul wide-body aircraft. The figures on the following page indicate the location of the airport in relation to its surroundings.

The runway system requires some upgrading and repairs to allow safe operations in compliance with ICAO Standards and Recommended Practices (SARPs). In addition, the development of Nacala as a civilian airport will require a full range of related facilities to support the proposed commercial air service with wide-body aircraft.

The following were identified in the USTDA Definitional Mission Report as urgent investments required at Nacala in order to be able to accommodate long-range international flights. During the site visit to Nacala Airport, AAROTEC reviewed the existing conditions and concurs with the recommendations of the USTDA Definitional Mission Report.

- Resurfacing of the existing runway system and installation of a modern lighting system;
- Expansion of the aircraft parking area;
- Improvement of the shoulders of the runway and taxiways;
- Improvement of the security zones at the end of the thresholds;
- Installation of all navigational aids recommended for an airport with the level of traffic and the size of aircraft planned for this aerodrome;
- Establishment of a new adequate fire rescue station, including new equipment;

- Provision of electrical services for the airport including main standby power;
- Construction of a new passenger terminal and a new cargo terminal;
- Installation of new ground handling equipment;
- Modernization of the air traffic control tower and implementation of the new technical buildings in the operational area;
- Improvement of the access and perimeter roads to the proposed terminal areas.

Nacala Airport

Nacala Airport Surroundings

Airside Infrastructure

The existing airside infrastructure at Nacala airport is summarized in the following table.

Nacala Airport Existing Airside Infrastructure	
Coordinates	S 14:28.8; E 40:42.5
Elevation	125 meters above sea level
Reference Temperature	29 degrees Celsius
Runway	
ICAO Code	4D
Orientation	01/19
Dimensions	2,500 m x 45 m
Slope	NA
Surface	Asphalt
Surface conditions	Cracks and loose materials
Strength	NA
Shoulders	No
Lighting	No
Runway centerline to taxiway centerline distance	210 m
Taxiway	Full parallel
Dimensions	2,500 m x 23 m
Surface	Asphalt
Surface Conditions	Cracks and loose materials
Shoulders	No
Lighting	No
Civil aviation apron	
Dimensions	100 m x 120 m
Surface	Asphalt
Surface Conditions	Cracks and loose materials
Shoulders	No
Lighting	No
Military aviation aprons (2)	
Dimensions	285 m x 85 m and 285 m x 75 m
Surface	Asphalt
Surface Conditions	Cracks and loose materials
Shoulders	No
Lighting	No

The airside configuration of the airport has the general geometric characteristics of an ICAO Code D airport. Its runway length has the capacity to operate Code C aircraft with 100% payload and Code D aircraft with 90% payload. The airfield has no visual aids for navigation

The existing airside pavements show visible distresses and deterioration such as alligator cracks and superficial loose material. All pavement areas are in need of asphalt overlays.

Landside Infrastructure

The existing landside infrastructure consists of the following elements:

A Multi-Purpose Building measuring approximately 192 m^2 is located adjacent to the existing aircraft parking apron. It is currently used for meetings with theater-style seating and has a capacity of approximately 30 people. It is a simple utilitarian shelter constructed of plastered concrete masonry walls, concrete floor and a sloped, wooden roof structure supported by iron railroad rails functioning as rafters. The roof structure is sagging and should be strengthened with additional supporting roof rafters if this building is to continue in use.

The Military Base contains multiple buildings and the northwestern apron contains a large metal hangar, measuring approximately 16,000 m^2. It is constructed of a steel frame and metal wall cladding and exhibits an advancing degree of corrosion.

The main airport access road and the interior road which leads to the civil aviation apron are unpaved dirt roads. Although, the dirt surfaces remain compacted during the dry season the surfaces are muddy during the rainy season.

The Air Traffic Control Tower structure, located adjacent to the central access Taxiway, is approximately 12 m high and measures 10 m square at its base. The tower is constructed of plastered, concrete masonry walls, concrete floors and a sloped metal roof. It is inoperative at present; all windows have been destroyed and only the concrete structure has remained standing. Although, the building appears to be structurally sound, it is inoperative at present.

The Fuel Storage Area is located due south of the Civil Aviation Apron, across from the airport's Main Access Road. The Fuel Storage Area contains an underground storage tank with a 60,000 l capacity which has been abandoned in place and is not usable.

Operating Performance and Constraints

The airport contains large expanses of open land which can provide for unconstrained development of civil aviation facilities. If the airport is to be used for civilian commercial air traffic, even under minimal non-precision approach procedures, all lights, indicators and markings required by ICAO will have to be installed.

With respect to the landside, there are no civil aviation facilities at Nacala Airport at present. If the airport is to be used for civilian commercial air traffic, it will need all infrastructure facilities, such as access roads, vehicular parking areas, a terminal building, fire fighting equipment and installations, electrical power, water, telephone lines, a new fuel farm, maintenance areas, etc.

Forecast of Demand

Historical Air Traffic Data

Data provided by ADM demonstrate that total air traffic in Mozambique has experienced strong and sustained growth over the past twelve years for all of the

standard indicators of aviation activity: passengers, aircraft movements, air cargo and mail. In particular, passenger flows have increased from 523,500 in 1995 to 1,363,000 in 2006; aircraft movements from 34,100 in 1995 to 51,900 in 2006; air cargo and mail combined from 5,900 tons in 1995 to almost 13,400 tons in 2006.

Pemba

Air traffic indicators at Pemba airport indicate very strong and sustained growth over the past decade. Passenger flows have gone from a mere 17,600 in 1995 to 90,500 in 2006 (i.e. an increase of over five times); aircraft movements from only 960 in 1995 to almost 6,300 in 2006; air cargo and mail combined from 260 tons in 1995 to over 840 tons in 2006.

The resulting average annual growth rates over this period were 17.9% for passengers, 21.5% for aircraft movements and 12.9% for air cargo and mail combined. Although, the historical figures show some variation in the pattern of growth over this period, the general trend indicates an extremely strong progression of the principal air traffic indices, especially in the case of total passengers and combined air cargo and mail, which constitute the main drivers of aviation activity.

Nampula

Nampula airport now serves as the only gateway to the Nacala region, even though it is approximately three hours away by road; therefore, we examined the air traffic patterns at Nampula as part of our methodology for determining the forecast of air traffic at Nacala. Air traffic indicators at Nampula airport indicate strong and sustained growth over the past decade. Passenger flows have gone from 47,800 in 1995 to 141,600 in 2006 (i.e. an increase of almost three times); aircraft movements from 2,150 in 1995 to over 3,500 in 2006; air cargo and mail combined from 530 tons in 1995 to 1,340 tons in 2006.

The resulting average annual growth rates over this period were 11.6% for passengers, 6.2% for aircraft movements and 10.0% for air cargo and mail combined. Although, the historical figures show some variation in the pattern of growth over this period, the general trend indicates a very strong progression of the principal air traffic indices, especially in the case of total passengers and combined air cargo and mail, which constitute the main drivers of aviation activity.

Conclusions

The historical air traffic statistics for Pemba and Nampula airports indicate a stronger rate of growth over the last decade than that of the ADM system as a whole. Passenger traffic at Pemba, in particular, grew at a rate over twice that of the total ADM passenger traffic during the same period. Aircraft movements at Pemba increased at almost four times the rate for the ensemble of ADM airports. Air traffic indicators at Nampula show a similar tendency; although, the difference in growth rates is not as striking.

Air Traffic Forecasts

Forecasts of airport activities were prepared in terms of passengers, aircraft movements and air cargo tonnage. For purposes of sensitivity analysis, these were prepared in the form of three scenarios for each airport: Base Case, Optimistic and Pessimistic.

Pemba

Taking the traffic recorded at Pemba in 2006 as the base year, AAROTEC developed projections of annual passengers at Pemba airport for the Base Case Scenario, broken down by traffic sector and corresponding to the following annual growth rates:

domestic sector	origin/destination traffic	6.0% (2007-2016) 5.0% (2017-2028)
	transit traffic	3.0%
regional sector	origin/destination traffic	11.0% (2007-2016) 10.0% (2017-2028)
	transit traffic	3.0%
international sector		5000 passengers (2011) 10000 passengers (2012) 15000 passengers (2013) 14.0% (2014-2028)
other	non-commercial traffic	11.0%

The resulting passenger volumes are as shown in the following table:

Pemba Airport Air Traffic Projections (2007-2008) – Base Case

	Annual Passengers								
	domestic			regional			other	int'l	total
	orig/dest	transit	sub-total	orig/dest	transit	sub-total			
2006	56 267	17 626	73 893	6 950	8 095	15 045	1 549	0	90 487
2007	59 643	18 155	77 798	7 715	8 338	16 052	1 595	0	95 446
2008	63 222	18 699	81 921	8 563	8 588	17 151	1 643	0	100 715
2009	67 015	19 260	86 275	9 505	8 846	18 351	1 693	0	106 319
2010	71 038	19 838	90 874	10 551	9 111	19 862	1 743	0	112 279
2011	73 631	20 433	94 065	11 184	9 384	20 568	1 796	5 000	121 428
2012	78 049	21 046	99 096	12 414	9 666	22 080	1 850	10 000	133 025
2013	82 732	21 678	104 410	13 779	9 956	23 735	1 905	15 000	145 050
2014	87 696	22 328	110 024	15 295	10 255	25 550	1 962	17 100	164 638
2015	92 958	22 998	115 956	16 978	10 562	27 540	2 021	19 494	165 010
2016	98 535	23 688	122 223	18 845	10 879	29 724	2 082	22 223	176 252
2017	103 462	24 399	127 861	20 730	11 205	31 935	2 144	25 334	187 274
2018	108 635	25 130	133 766	22 803	11 542	34 344	2 359	28 881	199 349
2019	114 067	25 884	139 951	25 083	11 888	36 971	2 594	32 925	212 441
2020	119 770	26 661	146 431	27 591	12 244	39 835	2 854	37 534	226 655
2021	125 759	27 461	153 219	30 350	12 612	42 962	3 139	42 789	242 109
2022	132 047	28 285	160 331	33 385	12 990	46 375	3 453	48 779	258 939
2023	138 649	29 133	167 782	36 724	13 380	50 103	3 799	55 608	277 292
2024	145 581	30 007	175 589	40 396	13 781	54 177	4 178	63 393	297 338
2025	152 861	30 907	183 768	44 436	14 195	58 630	4 596	72 269	319 263
2026	160 504	31 835	192 338	48 879	14 620	63 500	5 056	82 386	343 280
2027	168 529	32 790	201 318	53 767	15 059	68 828	5 561	93 920	369 626
2028	176 955	33 773	210 728	59 144	15 511	74 655	6 118	107 069	398 570

Nacala

For the proposed new civilian airport facilities at Nacala, AAROTEC developed projections of air traffic indicators based on an assumed initial shift of portions of domestic commercial traffic from Nampula in 2010-2011 together with the initiation of

regional air traffic at the same time. Other (non-commercial traffic) is assumed to commence in 2008, following the transfer of management of the facilities to ADM and opening of the airport to civilian general aviation.

Passenger traffic is assumed to commence in 2010, following construction of a terminal building and revision of the aircraft parking apron to accommodate commercial flights. The passenger volumes for the Base Case were broken down by traffic sector and correspond to the following annual growth rates:

domestic sector	origin/destination traffic	8.0% (2010-2018) 7.0% (2019-2028)
	transit traffic	3.0%
regional sector	origin/destination traffic	11.0% (2010-2018) 10.0% (2019-2028)
	transit traffic	3.0%
international sector		14.0%
other	non-commercial traffic	11.0%

The resulting passenger volumes are as shown in the following table:

Nacala Airport Air Traffic Projections (2007-2028) – Optimistic Case

	Annual Passengers								
	domestic			regional			other	int'l	total
	orig/dest	transit	sub-total	orig/dest	transit	sub-total			
2006	0	0	0	0	0	0	0	0	0
2007	0	0	0	0	0	0	0	0	0
2008	0	0	0	0	0	0	1 500	0	1 500
2009	0	0	0	0	0	0	1 560	0	1 560
2010	34 949	10 485	45 434	10 000	9 000	19 000	1 607	0	66 041
2011	75 466	10 799	86 265	11 300	9 270	20 570	1 655	5 000	113 490
2012	83 012	11 123	94 135	12 769	9 548	22 317	1 705	10 000	128 157
2013	91 313	11 457	102 770	14 429	9 835	24 264	1 756	15 000	143 790
2014	100 445	11 801	112 245	16 305	10 130	26 434	1 808	20 000	160 488
2015	110 489	12 155	122 644	18 424	10 433	28 858	1 863	23 000	176 364
2016	121 538	12 519	134 057	20 820	10 746	31 566	1 919	26 450	193 992
2017	133 692	12 895	146 587	23 526	11 069	34 595	1 976	30 418	213 575
2018	147 061	13 282	160 343	28 584	11 401	37 985	2 174	34 980	235 482
2019	160 297	13 680	173 977	29 775	11 743	41 518	2 391	40 227	258 113
2020	174 723	14 091	188 814	33 348	12 095	45 443	2 630	46 261	283 148
2021	190 448	14 513	204 962	37 349	12 458	49 807	2 893	53 200	310 863
2022	207 589	14 949	222 537	41 831	12 832	54 663	3 183	61 180	341 564
2023	226 272	15 397	241 669	46 851	13 217	60 066	3 501	70 358	375 595
2024	246 636	15 859	262 495	52 473	13 613	66 086	3 851	80 911	413 344
2025	268 833	16 335	285 166	58 770	14 022	72 791	4 236	93 048	455 244
2026	293 028	16 825	309 853	65 822	14 442	80 264	4 660	107 005	501 782
2027	319 401	17 330	336 731	73 721	14 876	88 596	5 126	123 056	553 508
2028	348 147	17 850	365 997	82 567	15 322	97 889	5 638	141 514	611 038

Preliminary Comparative Financial Feasibility Analysis

As specified in the Terms of Reference, AAROTEC performed a preliminary comparative financial analysis of airport facility development programs aimed at accommodating long-range international air traffic for both options: Pemba and Nacala. The required investments at each site were evaluated in terms of standard

indicators of financial performance. The financial analyses were based on the forecasts of traffic at each airport and preliminary capital investment requirements as presented in the Inception Report.

Based on the Net Present Value (NPV), upgrades of both Pemba Airport and Nacala Airport to International Status would be justified; NPVs for both are positive, meaning that the Internal Rate of Return (IRR) (15.86% and 19.91%, respectively) would exceed the Weighted Average Cost of Capital (WACC) of 11.35% in each case.

Based on the calculated IRR; however, upgrade of the Nacala military airfield to international commercial airport status would be the preferable choice, since its IRR of 19.91% not only exceeds the ADM target investment rate of 18% but is some 26% higher than the corresponding IRR for a comparable expansion of Pemba airport, which does not achieve the above-mentioned ADM target investment rate.

Legal Framework for Transfer of Nacala Airport

The lands that form the Nacala military base have been used as such since colonial days. As a government owned military base it lies within a Total Protection Zone as defined in Article 7 of the Land Law No. 19/97 of 1 October 1997. Airport facilities, on the other hand, are listed specifically in Article 8(i) as being in a Partial Protection Zone. Article 22(3) (b) allows the Council of Ministers to create, modify or extinguish protected zones, and thus to modify the existing Total Protection Zone to a Partial Protection Zone for civilian use. This Article also empowers the Council of Ministers to increase the land area of the airport if, in extending the runway or in creating a shared facility, additional land is required. If some of the land that is required for expansion is already occupied, Article 18(1) (b) gives the government the right of eminent domain to acquire the land use rights of others for the public benefit.

With respect to laws, decrees or protocols, providing guidelines for airports where the Military and Civilians use the same runway, navigational, and ATC facilities, this arrangement has existed informally since Colonial days ; although, no writing exists. Currently there appear to be few problems with the arrangement.

Decree 3/98 of 10 February 1998 sets forth the rights, duties and powers and includes, as an annex, the Corporate Charter of ADM. Article 3 of the Charter gives ADM the exclusive right to establish airports and to operate, maintain and improve airport facilities and Article 7 specifies the powers of the Board of Directors, including the power to approve the acquisition of new properties *et al.*

The Government has published an extensive document outlining its road map for development, entitled Agenda 2025. In this document, the development of Nacala as an international civilian airport is listed specifically as a goal to be achieved prior to the year 2025. Although, the Agenda represents Government policy, rather than binding law, it appears that there will be little opposition to the transfer of all or part of Nacala to a civilian facility on the part of the Council of Ministers.

In addition to the above-mentioned legal texts, the Ministry of Transport and Telecommunications and the Ministry of National Defense signed a Memorandum of Understanding dated August 21, 2006. This agreement stipulates *inter alia* that the two ministries will cooperate and coordinate their activities in creating common fields of activity and that they will, through their respective structures; establish programs aimed at the efficient management of the actions evolving from the above-mentioned Memorandum.

In particular, the Memorandum states that the two ministries will promote institutional partnership in the maritime, aviation, telecommunications, infrastructure and road fields. In the field of Aviation, the parties, in partnership, undertake to:

a) Establish a Civil/Military Coordination Commission for the control of the national airspace;

b) Mobilize resources for the acquisitions of equipment for the control of the national airspace;

c) Cooperate in the training of aeronautical personnel, in particular pilots, air traffic controllers, aeronautical mechanics, flight operations technicians, *inter alia* and establish a system of respective equivalencies;

d) Coordinate activities of search and rescue using the equipment of both parties, and;

e) Establish standards and additional mechanisms for the management and control of the national airspace.

In the field of Infrastructure, the parties, in partnership, undertake *inter alia* to coordinate the use of part of any installations of the [military] Air Bases and Aerodromes for civilian purposes. For the purposes of the execution of this Memorandum with respect to infrastructure, the Ministry of Transport and Telecommunications designates as its representative the National Directorate of Economy and Investments.

Although, this Memorandum provides a general framework for an eventual agreement regarding the transfer of part of the Nacala Air Base to civilian administration as a commercial airport, it does not mention any specific mechanism for such a transfer. This would require a more specific agreement between the two ministries and, as stated previously, a duly adopted decree of the Council of Ministers.

Evaluation and Selection of Alternatives

The following paragraphs discuss the comparison of the two options for the development of airport facilities in the northern coastal region of Mozambique as defined in the Terms of Reference of the present study:

1) The expansion of Pemba airport, including the extension of the runway and the provision of additional taxiway, apron and terminal facilities, in order to be able to accommodate long-haul international flights.

2) The conversion of the Nacala military airfield to civilian use, including the upgrading of the existing runway, taxiway and apron facilities and the provision of air navigation, air traffic control and passenger terminal facilities, in order to be able to accommodate commercial aviation, including long-haul international flights.

The primary objective is to determine the order of priority for the construction of long-range international airport facilities in northern Mozambique while considering the ultimate costs and benefits of the alternative development programs.

Technical Analysis

Our technical analysis indicates that either course of action is technically feasible. This being said, the development of Nacala airfield as a civilian airport, equipped to handle long-haul commercial flights (Option B), will present fewer technical challenges, due to the length of the existing runway (2,500 m) and the extensive flat land area on which the present facilities are located. Very simply stated, Nacala can be developed and expanded for the foreseeable future with virtually no technical constraints.

The same cannot be said for the expansion of Pemba airport to handle long-haul international flights (Option A), which would require a massive program of earthworks and disruption of the local environment in order to provide for the required extension of the runway. Further, even the realization of the large-scale site works necessary for extension of the runway will not remove the limitations on expansion of the airport facilities, due to the presence of roads and other infrastructure surrounding the airport. Very simply stated, the inherent site constraints of Pemba airport mean that it can only be expanded at great expense and with limited long-term benefit.

Legal Analysis

From the legal perspective, either project can be accomplished with minor legal intervention. The method for transferring land to ADM from the Military is set forth clearly in the Land Law, and requires a decree or resolution from the Council of Minister.

The method for acquiring additional land around the Pemba airport, if it is selected, is also set forth quite clearly in the eminent domain section of the land law. Once either parcel is held by ADM, it has the legal authority to develop, create and supervise airport activities as its board of directors designate, pursuant to it's only enabling Decree.

The only serious legal obstacle facing either airport is the filing of the necessary Preliminary Environmental Information Sheet and seeking either a new categorization of the project or an official confirmation that it may proceed as an exempt project.

Financial Analysis

The financial analysis indicates that both options (Pemba and Nacala) for the upgrading of airports in the northern coastal area to international status would be justified on basis of the net present value (NPV) of the required investments. In both cases, the NPVs are positive, meaning that the Internal Rate of Return (IRR) would exceed the Weighted Average Cost of Capital (WACC). More specifically, the IRR for Option A (Pemba) was calculated to be 15.86%; whereas, the IRR for Option B (Nacala) was calculated to be 19.91%), both of which are in excess of the required WACC of 11.35%. This being said, the upgrading of Nacala to international status would be the preferable choice; since the calculated IRR (19.91%) exceeds the ADM target investment rate (18%), as well as the WAAC (11.35%).

Effects on Vilankulos and Other Airports

It was thought that the proposed investments for the improved airport facilities at Pemba and/or Nacala might have an impact on the expected levels of traffic at other airports in the ADM system. Although, the Terms of Reference of the present study identified Vilankulos airport as being susceptible to the possible diversion of air traffic to airports in the north of the country, we have concluded that the airport most likely to feel the effects of expanded facilities at Pemba or Nacala would instead be Nampula. After having analyzed the traffic patterns and discussed with economic agencies and tourism operators, it became obvious that a portion of the air traffic at Nampula airport has its ultimate origin/destination in the Nacala sub-region (Nacala City and its associated tourism destinations).

Conclusion and Selection of Alternative

Considering the long-term costs and benefits of the two options, AAROTEC recommends that priority be given to the development of Nacala as an international airport, since construction of the required infrastructure to accommodate long-range flights and future expansion is more feasible at this site. At the same time, since a limited extension of the runway, together with minor upgrades and expansion of the passenger terminal at Pemba appear to be economical in the short term, AAROTEC recommends a strategy which allows both areas to enjoy improved air service.

In terms of the implementation of a phased development strategy, Nacala should be designated immediately as a general aviation airport while looking toward eventually upgrading to a commercial airport. Nacala can be designated as a general aviation airport with hardly any investment cost and then to charter service and eventually to a bare bones international airport as passenger traffic to the region justifies the action.

Demand/Capacity and Facility Requirements

AAROTEC performed a demand/capacity based on the above-mentioned forecasts of activities at Nacala and Pemba airports in order to determine the facility requirements necessary to accommodate the expected traffic under the following

scenario: (1) development of Nacala as an international airport capable of handling wide-body long-range airline services; (2) development of Pemba with a primary location as an airport capable of accommodating medium-range aircraft.

Nacala Airport

The following is a summary of the major airfield infrastructure investment needs that comply with ICAO Standards, for a Code 4-E Aerodrome with non-precision approach procedures:

1. Runway pavement overlay
2. Runway shoulders
3. Runway end safety areas
4. All visual aids for navigation
5. Equipment and electrical installations
6. Emergency services
7. Air traffic control tower and associated communications equipment
8. Perimeter fence and perimeter road

In addition to the above, conversion of the existing Nacala military airfield to civilian service will require the construction of the following airport landside facilities:

1. Passenger terminal building
2. Air traffic control tower
3. Aircraft fire-fighting and rescue facility (AFFR)
4. Air cargo terminal
5. Airfield maintenance facilities
6. Access roads and parking facilities
7. Other support services and utilities

Pemba Airport

Following is a summary of the major infrastructure development investment needs to comply with ICAO Standards, for a Code 4-C Aerodrome with non-precision approach procedures:

1. Runway pavement overlay
2. Runway end safety areas
3. Some visual aids for navigation such as signaling, markings and aeronautical beacon
4. Upgrade emergency Services
5. Perimeter fence and road

In addition to the above, expansion of Pemba airport will require the construction of the following airport landside improvements:

1. Expansion of the passenger terminal building
2. Improvement of the landside road and parking facilities

Conceptual Drawings and Development Plans

AAROTEC prepared conceptual drawings and development plans for Nacala and Pemba airports, based on the demand/capacity analysis and determination of facility requirements described above. These included the following:

Runway, Taxiway and Aprons

The sizes of the different areas of pavement proposed for aircraft operations, namely, the runway taxiways and aprons, are based on the basis of the aircraft fleet and the peak hour operations forecast. The exception to this methodology is the length of the runway. On the basis of the fleet mix and stage length forecasts, the initial runway lengths were proposed to be 2,500 m in the first phase (ICAO Code 4D) and 3,100 m in the second phase of development (ICAO Code 4E).

Pavement Design

The type and size of aircraft expected to use the proposed International Airport ranges from the RJ-100 to the A340-200. The B737, B767, B747-100, A310 and A320 are also included as probable aircraft which will be used by carriers on the regional and international routes. The strength (thickness) of the pavement is based on the results of the preliminary study with this aircraft mix, the forecast number of operations and maximum takeoff weights (MTOW).

Visual Aids, Meteorological Equipment and Navaids

Visual aids at both Pemba and Nacala airports will consist of the following items:

- High-intensity runway edge lighting (HIRL)
- Runway end identifier lights (REILs)
- Precision approach path indicators (PAPIs), at both ends of runway
- Taxiway edge lighting (MITL)
- Runway marking in accordance with the ICAO recommendations for precision runway operations
- Taxiway marking consisting of centerline and side stripes and holding markers
- Angled marking for all paved shoulders

Meteorological Services and Equipment

- Temperature/dew point gauge
- Anemometer
- Barometer
- Rain gauge
- Ceilometers
- Runway visual range transmitter and receiver

Navaids

The International Airport should eventually be provided with a complete instrument landing system (ILS) when traffic will justify the installation. However these facilities are not included in the present proposed plans. This will include the following components:

- Outer marker
- Middle marker
- Glide slope transmitter
- Localizer transmitter

Buildings

Conceptual studies for the passenger terminal, cargo terminal, airport traffic control tower facility and airport rescue and fire fighting facility/airfield maintenance building were based on forecasts of passenger aviation activity, forecasts of freight activity, and related information contained in other sections of this report. Utilizing the International Air Transport Association (IATA), "Airports Terminals Reference Manual"; the International Civil Aviation Organization's (ICAO) Annex 14, Aerodromes; and accepted standards of aviation facility design, a space analysis for major functions of each facility was prepared. Further evaluation and analysis allowed for development of a detailed building area program that identified required spaces and assigned an area calculation to each space. From this program, floor plan drawings were prepared that graphically presented the building space program.

Each of the four buildings designed for the new International Airport have unique characteristics and functions that must be addressed and understood in order for the design to be functional, economical and yet an aesthetic part of the environment.

- Nacala International Airport Development – New International Terminal Building
  - landside interface
    - passenger processing
    - passenger holding and concessions
    - circulation,
    - airside interface, and
    - air carrier support spaces
- Nacala International Airport Development – Air Traffic Control Tower Facility
- Nacala International Airport Development – Rescue / Fire Fighting Facility
- Nacala International Airport Development – Cargo Terminal
- Pemba Regional Airport Development – Improvement to Existing Terminal
  - Add X-ray/security check at building entrances
    - Increase size of departure lounge
    - Increase size of baggage claim area
    - Provide separate baggage claim for domestic arrivals & regional arrivals
    - Add office area for Ministry of Tourism and Culture
    - Increase sales area

Landside Site Work and Utilities

Road Network and Parking Facilities

- Main Entrance Roadway
- Internal Airport roads
- Parking Areas
  - Adjacent to the passenger terminal – initial capacity 100 vehicles; reserved area for 300
  - Smaller parking areas for airport employees.

Utilities

- Storm Drainage
- Water Distribution System
- Sewer System
- Electrical Distribution System

Security

- Site Security
- Building Security

AutoCAD Drawings

The drawings in AutoCAD format are listed below and physically appear in a separate Appendix which forms part of the present Final Report. They are listed on the following pages for Nacala and Pemba airports:

Nacala International Airport

Airport Layout Plan	AA ALP 01
Terminal Area Plan	AA TAP 01
Terminal Floor Plan Arrival & Departure	NT 02
Arrival Area Floor Plan	NT 02A
Departure Area	NT 02D
Terminal Sections A-B-C-D	NT 03
Terminal Sections E-F-G	NT 04
Departure Area Floor Plan with Dimensions	NT 05
Arrival Area Floor Plan with Dimensions	NT 06
Terminal Elevations	NT 07
Terminal Elevations	NT 08
Reflective Ceiling Plan	NT 09
Terminal Floor Plan Passenger Path	NT 10
Lighting Plan Arrival Area	EA 01
Lighting Plan Departure Area	EA 02
Terminal Power Plan Arrival Area	EA 03
Terminal Power Plan Departure Area	EA 04
Omitted	EA 05
Omitted	EA 06
Power – One Line Riser Diagram	EA 07
Equipment Layout Plan & Power Distribution Plan	EA 08
Terminal Mechanical Plan Arrival Area	MA 01
Terminal Mechanical Plan Arrival Area	MA 02

Structural Notes	SA 01
Terminal Foundation Plan Arrival Area	SA 02
Terminal Foundation Plan Departure Area	SA 03
Terminal Framing Plan Arrival Area	SA 04
Terminal Framing Plan Departure Area	SA 05
Terminal Framing Plan Second Floor	SA 06
Terminal Framing Details Column Schedule	SA 07
ARFF & AFM Floor Plan	ARFF 01
ARFF & AFM Floor Plan Sector A	ARFF 02
ARFF & AFM Floor Plan Sector B	ARFF 03
ARFF & AFM Elevations	ARFF 04
ARFF & AFM Section 'C'	ARFF 05
ARFF & AFM Section 'B'	ARFF 06
ARFF & AFM Section 'A'	ARFF 07
ATC Building Floor Plans 1 & 2	ATC 01
ATC Building Floor Plans 3-4-5 & 6	ATC 02
ATC Building Front Elevation	ATC 03
ATC Building Back Elevation	ATC 04
ATC Building Side Elevation	ATC 05
ATC Building Cross Sections	ATC 06
Cargo Building Floor Plan Level 1	C 01
Cargo Building Floor Plan Level 2	C 02
Cargo Building Elevations	C 03
Cargo Building Sections	C 04
Cargo Building Section A	C 05
Cargo Building Section B	C 06
Cargo Building Section C	C 07

Pemba Airport

Pemba Passenger Terminal Expansion-Phase One	AA01-P1
Pemba Passenger Terminal Expansion-Phase Two	AA01-P2
Airport Layout Plan	AA01-P3
Terminal Area Plan	AA01-P4

Environmental Impact

Local Mozambique Policies and Regulations

The primary law governing the environmental aspects of the proposed development of Nacala airport is the Environmental Protection Law (Law No. 20/97 of 1 October 1997) and the Regulations on the Environmental Impact Assessment Process (Decree No. 45/2004 of 24 August 2004).

Based on our analysis of the proposed Nacala airport development program and nature of the surrounding lands, the project is not likely to cause any large-scale or irreversible damage to the physical or social environment; nor does the surrounding

area fall under the World Bank's definition of fragile or environmentally sensitive lands. Therefore, we believe that the proposed project would not require a full Category A Environmental Assessment according to World Bank policies and regulations. We believe that a Category B Environmental Assessment would be applicable to this project if it were to comply with World Bank policies and regulations.

Capital Cost and Investment Requirements

The costs of developing civilian airport facilities to handle scheduled international air services at the Nacala air base are summarized in the following table, which shows the proposed phasing of the recommended capital expenditures. The column labeled "sub-total basic project" represents the basic investments required to meet the safety and security needs of the airport, i.e. those elements to be installed or constructed during the planning period. It is expected that these costs would be financed by the cash flow of the project. The column labeled "sub-total ultimate project" represents the additional investments remaining to be completed later or provided by grants or soft loans if available. The "grand total" column on the right is the sum of the "sub-total basic project" and the "sub-total ultimate project" columns on the left.

Nacala Airport International Development Cost and Phasing (US$x1000)

	2009	2013	2018	2028	Sub-total Basic Project	Sub-total Ultimate Project	Grand Total
Passenger Terminal Building	3,887			3,887	7,773	5,182	12,955
A.T.C. Building		501			501	1,504	2,006
ARFF-AMB Building		642	642		1,283	1,283	2,567
Cargo Terminal Building		1,198		1,198	2,396	2,396	4,791
Grand Total Construction Cost	**3,887**	**2,341**	**642**	**5,084**	**11,953**	**10,365**	**22,318**
Passenger Terminal Equipment		882	800		1,682		1,682
ARFF Equipment		600	600		1,200	547	1,747
Airport Maintenance Equipment		192	200		392		392
Miscellaneous Equipment		522			522		522
Total Equipment Cost	**0**	**2,196**	**1,600**	**0**	**3,796**	**547**	**4,343**
Airfield work	1,229		614	1,229	3,072	9,215	12,287
Site Work	1,135	3,406	568		5,109	6,244	11,353
Total Cost of Airfield	**2,364**	**3,406**	**1,182**	**1,229**	**8,181**	**15,459**	**23,640**
Grand Total Development Cost	**6,251**	**7,943**	**3,424**	**6,313**	**23,930**	**26,372**	**50,301**

Financial Feasibility Analysis

AAROTEC performed a detailed financial analysis for the proposed Nacala Airport development program which is intended to assist ADM in formulating a plan for upgrading the airport to international status and arranging financing to implement this plan. This analysis was based on conventional techniques utilized in the airport industry and known sources of financing. The basic inputs were the traffic forecasts and investment costs described previously in this report, as well as the financial data relating to ADM operational costs and revenues.

The financial analysis demonstrated that ADM would be justified in upgrading the existing military facility at Nacala to the status of an international airport, based on the financial performance measures explained above. Specifically, the proposed development program would be both affordable (the 20.24% IRR would exceed the 13.81% WACC) and acceptable (the 20.24% IRR would also exceed the 18.00% ADM target investment rate).

Development Impact Considerations

The proposed conversion of the Nacala military airfield to a civilian airport capable of accommodating domestic, regional and international commercial air services will have a significant impact on the economic and social development of the surrounding region. In particular, it will have an immediate and direct impact in improving the capacity of the regional infrastructure and the competitiveness of local industry (including tourism); it will also contribute indirectly to the implementation of market-oriented reforms, the optimization of human capacity, the transfer of technology and the enhancement of productivity.

Infrastructure and Industry

Implementation of the proposed airport development program at Nacala will provide a key missing component of transportation infrastructure to the city and its surrounding area. The proposed airport project will form part of an integrated and balanced transportation infrastructure network serving a region with great potential; it is not an isolated investment. The role of the airport improvement project as a catalyst for the completion of this larger network is thus critical as part of a regional infrastructure development strategy.

The implementation of the airport project will also contribute significantly to making the industries of Nacala more competitive both within Mozambique and at the regional level of Southern Africa.

The nascent tourism industry in the Nacala region will benefit substantially from the implementation of the proposed airport development project. In fact, this sector will probably be the most immediate beneficiary of the proposed investment. Although, the Nacala region enjoys undeniable potential for tourism as a result of the quality of its beaches, historical sites and underwater phenomena, the availability of good air access to international source markets constitutes a *sine qua non* for the development of this resource. Without airport facilities capable of accommodating flights from these markets, it is highly unlikely that any significant private investments will be made to develop the kind of hotel/resort infrastructure that will attract international tourists.

Market-Oriented Reforms

The optimization of the investment to be made at the airport will depend on the extent to which the local authorities join forces with ADM to manage the industrial,

commercial and tourism development generated by the airport activities. At the same time, the local authorities should ensure that the necessary legal instruments are in place to control encroachment by residential and other non-compatible land uses under the sensitive areas around the airport, thus compromising the safety of flight operations, causing nuisance to the populations and limiting the long-term expansion of aviation activities.

Finally, the implementation of new airport facilities at Nacala should be accompanied by confirmation on the part of the Government to ensure the economic deregulation of the Mozambique air transport market and, in particular, the application of the letter and the spirit of the Yamoussoukro Decision regarding the Liberalization of Air Transportation on Africa.

Human Capacity Building

The implementation of the new civilian airport facilities will generate an estimated total of over 70 jobs in the airport administration alone. A description of the number and type of positions that would be needed in the airport administrative staff is given in the section of this report which details the financial aspects of the project. The managerial level positions will all require specialized training, to be arranged through ADM and including management skills, safety/security and airport maintenance procedures, facilitation, etc.

In addition, the direct creation of other jobs at the airport will include those of airlines, aircraft ground handling agencies, taxis, freight forwarders and cargo operators, flight kitchens, aircraft refueling depots, car rental agencies, concessionaires, etc. In addition to the employment opportunities created at the airport, the air traffic activity will create significant indirect employment in the Nacala area for suppliers of various services to operators at the airport, as well as through the "multiplier" effect generated by direct airport employment. Finally, the development of the airport will stimulate industrial/commercial activity in the Nacala region as described above and will create the essential conditions for the realization of the significant tourism potential of the area. Taken together, the employment generated by such economic activities will number well into the thousands, although it is not possible to indicate a specific number at this point in time.

Technology Transfer and Productivity Enhancement

Implementation of the project will involve the use of a number of advanced technologies in the areas of telecommunications and air navigation equipment. It will also introduce airline reservation systems (software and hardware) into the local economy. The most significant enhancement of productivity; however, will result from the improvement of access to markets for the region's products, whether in the field of industrial/agricultural production or tourism.

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SECTION 1: INTRODUCTION

1.1 Context

Aeroportos de Moçambique (ADM), as an autonomous and financially independent state company under the tutelage of the Ministry of Transportation and Communications, has a broad mandate to support economic development and tourism throughout the country. This includes the northern coastal region where the Government has received demands from communities for improvements in the capacity of airports to accommodate a wider range of air services.

Various considerations for airport development in the northern coastal region have been put forth by successive governments, but no definitive long-term strategy for implementation has been decided. According to its mandate, ADM needs to proceed with a strategic planning process aimed at identifying an investment plan that responds to the needs of the region. The increased demand in the tourism sector due to interest in wildlife reserves and beach resorts on the coast; and the increase in mining and commercial activity in the northern part of the country, give the development of improved airport capacity for the region a high priority for ADM.

ADM and representatives of the social and economic stakeholders in the northern coastal area have identified two logical sites for the development of airport facilities to serve an expanded tourist market by accommodating long-range (inter-continental) flights according to two options: (a) large-scale expansion of the existing airport at Pemba and (b) conversion of the existing air force base at Nacala to civilian use.

The cities of Pemba and Nacala are located along the Mozambican coast of the Indian Ocean, approximately 815 km and 765 km respectively north of the capital city, Maputo. In addition to their importance as centers of administration and trade for their respective regions, both serve as essential gateways to natural and cultural tourist resources of great potential.

USTDA Technical Assistance

ADM has requested USTDA's assistance to fund a study that will allow the organization to focus on the short-term development of either Pemba or Nacala, while considering the effects of such development on the other ADM airports. Of particular importance to Airports of Mozambique, is the evaluation of potential issues related to converting the existing Nacala military airfield into a civilian commercial-use airport facility.

In the course of a recent Definitional Mission sponsored by USTDA, it was concluded that ADM needs to proceed with a strategic planning process aimed at identifying an

In the course of a recent Definitional Mission sponsored by USTDA, it was concluded that ADM needs to proceed with a strategic planning process aimed at identifying an investment plan that responds to (1) the needs of region; (2) the explosive increase and long-term potential of tourism due to wildlife viewing and beach resorts along the northern coastal region and (3) increased mining and commercial activity in the northern part of the country. The USTDA Definitional Mission Report proposed the preparation of a Feasibility Study to determine the requirements of expanding one of the airports, focusing on the preparation of forecasts of the expected air transport market demand and the technical, financial and legal feasibility of the proposed development project.

The present Feasibility Study forms part of the Technical Assistance program provided by the United States Trade and Development Agency (USTDA) to the Government of Mozambique. It concerns the preparation of the most appropriate plan for the development of the required facilities to accommodate the expected demands of the air transport market at the airports of Pemba and Nacala in the northern sector of Mozambique.

Development, Management and Role of Airports in Mozambique

Airports form a critical component of the overall transportation infrastructure in Mozambique, especially considering the current poor conditions of other modes of transportation such as roadways and railways. At present, the national airports system consists of 19 state-owned airports. In 1998, the Government of Mozambique transferred the operation of all state-owned airports to Aeroportos de Moçambique E.P. (ADM), an autonomous and financially-independent para-statal corporation under the tutelage of the Ministry of Transportation and Communications. The military aerodromes of Nacala and Cuamba, however, remain under the management of the Mozambican Air Force at present.

The mandate of ADM includes, *inter alia*, the operation, management, rehabilitation, financing and commercial development of the country's airports to serve the needs of the population and to foster tourism and economic development and growth of the various regions of the country.

Development of Tourism in the Northern Coastal Area

Of particular relevance to the development of the airport sector is the steady growth of tourism. In 2005, a record of almost one million tourists visited the country and during recent years the tourism sector has shown rapid increases particularly from visitors coming from other Southern Africa countries, Europe and the United States to the northern Mozambique coastal area. Mozambique's stated strategy to foster international tourism has focused on the following:

- Provision of convenient access to the unique wildlife, ecological and beach-front resources of the country;
- Development of a well-planned and professionally managed hospitality industry;
- Offering competitive services and access to the key tourist regions of the country.

In view of the relatively undeveloped potential of the attractive natural tourist resources of the Northern coastal area, the interest expressed by numerous tourism-sector operators and the inevitable limitations on the funding of the required airport development, ADM must plan an investment program which meets the needs of the populations it serves in the most rational and cost-efficient way. In doing this, ADM must consider carefully all of the issues associated with the development of the proposed airport facilities to serve this area.

Nacala Development Corridor

Both Pemba and Nacala are situated at the eastern edge of the "Nacala Development Corridor", an internationally recognized and designated zone of important trade and business activity linked to the excellent deep-water port facilities of Nacala. The geographic definition of the Nacala Development Corridor comprises a vast hinterland, including parts of Mozambique, as well as the land-locked countries of Malawi, Zambia and Zimbabwe. The enhancement of transportation infrastructure in the Nacala Development Corridor is considered to be a key component of regional economic integration and rationalization in Southern Africa and has the support of the governments and donor agencies concerned and a significant vector for economic growth in the agricultural, industrial, mining, fishing, tourism and import/export sectors.

Within Mozambique the Nacala Corridor area has seen significant development in recent years, with economic growth increasing at a rate more than four times higher than the rest of the country. This region is vital not only for the development of the tourism, but also plays an important role in fostering trade with neighboring countries including Malawi and Zambia and is a strategic route for local commerce. In this context, the modernization of infrastructure, including airports, is necessary to support growth of tourism, mining and other economic and commercial activities.

Infrastructure development is one of the key priorities of the government at the national level and Mozambique is supporting several other infrastructure projects in the Nacala Corridor, including a private railroad initiative carried out by US investors. This railroad will provide rail service from the port of Nacala to the Atlantic Ocean and ports in Namibia. Local and international private investors have also demonstrated interest in the development of improved airport facilities in the Northern area of Mozambique to better serve the resort zones of the Indian Ocean coastal area from Nacala to Pemba.

Pemba

ADM has received credible requests from European carriers to allow the operation of a wide-body aircraft at Pemba airport three times per week. Representatives of the national airline, LAM, have also confirmed that they would operate direct flights from several European capitals to Pemba if adequate facilities were in place. The existing facilities, however, do not have sufficient capacity to accommodate this demand;

therefore, the development of Pemba airport to accommodate long-haul flights would require a significant expansion of the existing facilities.

In particular, the existing main runway (1800 m) does not allow the operation of the proposed wide-body aircraft and the passenger terminal (1,100 sm) has already exceeded its capacity under the present passenger traffic. In addition, the airfield pavements require immediate attention, since they are deteriorating rapidly.

The following were identified in the USTDA Definitional Mission Report as urgent investments required at Pemba:

- Extension of the runway and taxiway;
- Resurfacing and reinforcement of the existing runway, taxiways and shoulders;
- Replacement and installation of a modern airfield lighting system;
- Possible implementation of an engineered materials arrestor system (EMAS) at the end of the security zone of the runway threshold;
- Expansion of the aircraft parking area;
- Expansion and modernization of the passenger terminal;
- Construction of a cargo area;
- Expansion of the fuel service area;
- Implementation of modern navigational aids;
- Upgrading of the fire rescue station including new equipment.

Nacala

Nacala airfield is currently managed by the Air Force and provides very limited accommodation for general aviation service. However, it is extremely well-located and may attract a significant portion (50% or more) of the country's air traffic which is currently served by the Nampula Airport. Although the immediate development of this airport may be favorable, ADM faces several regulatory barriers to transfer the management of this facility and therefore, this option needs to be studied in further detail.

The facilities at Nacala were not designed for commercial use. If Nacala is selected for short-term development, the construction of a new passenger terminal and cargo facilities will be required. This being said, the runway system (including taxiways) is 2,500 meters long and sufficient for departures of a range of long-haul wide-body aircraft. The runway system, however, requires some upgrading and repairs to allow safe operations in compliance with ICAO Standards and Recommended Practices (SARPs). In addition, the development of Nacala as a civilian airport will require a full range of related facilities to support the proposed commercial air service with wide-body aircraft.

The following were identified in the USTDA Definitional Mission Report as urgent investments required at Nacala:

- Improvement of the shoulders of the runway and taxiways;
- Improvement of the security zones at the end of the thresholds;
- Installation of all navigational aids recommended for an airport with the level of traffic and the size of aircraft planned for this aerodrome;
- Establishment of a new adequate fire rescue station, including new equipment;
- Provision of electrical services for the airport including main standby power;
- Construction of a new passenger terminal and a new cargo terminal;
- Installation of new ground handling equipment;
- Modernization of the air traffic control tower and implementation of the new technical buildings in the operational area;
- Improvement of the access and perimeter roads to the proposed terminal areas.

Vilankulos

- The Terms of Reference of the study has identified Vilankulos airport as being susceptible to the possible diversion of air traffic to airports in the north of the country. The study will look at the proposed investments in improved airport facilities at Pemba and/or Nacala, which may have an impact on the expected levels of traffic at other airports in the ADM system. The study will analyze the traffic patterns and have discussions with economic agencies and tourism operators, in order to best evaluate the effects on Vilankulos as well as other airports in the ADM system.

1.2 Objectives

The present study is intended to assist Airports of Mozambique (ADM) in determining the requirements and relative priorities for the expansion and upgrading of the airport facilities of Pemba and Nacala and the possible impacts of that development on Vilankulos as well as other airports in Mozambique. It is aimed at facilitating the implementation of the required airport improvements by elaborating a coordinated development plan which sets appropriate priorities for the necessary investment program and establishes the technical, legal, financial, economic and environmental feasibility of the recommended plan. A twenty-year investment program will be developed for the recommended airport.

1.3 Scope

According to the Terms of Reference, the study includes the following tasks:

- Identification of the airport recommended for immediate expansion and development;
- Preparation of passenger and cargo forecasts over a twenty-year period at the airports in question;
- Development of a demand-capacity analysis to compare the existing capacity at key facilities with forecast demand for the recommended airport;

- Development of facility requirements for short-term (five-year planning stages) and long-term scenarios for the recommended airport;
- Preparation of a conceptual plan and development program for the recommended airport based on forecast demand;
- Assessment of the financial, economic and environmental feasibility of the recommended development program.

1.4 Organization of the Report

The present Final Report is organized in four (4) volumes, as follows:

The **Executive Summary** provides a concise resume of the objectives, scope, analyses, findings and recommendations of this study. It is intended to facilitate the implementation of the proposed project by assisting the key decision-makers with a summary of the study.

The present main **Final Report** encompasses the text and results of the study and incorporates the comments received from ADM on the previous Inception Report, Interim Report and Draft Final Report. It is organized according to the tasks as specified in the Terms of Reference.

The **AutoCAD Drawings** are presented as a separate volume due to their large size, which does not lend itself to incorporation in the main body of the Final Report.

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SECTION 2: EXISTING AND PLANNED AIRPORTS INFRASTRUCTURE

2.1 Pemba Airport

Location

The immediate catchment area of Pemba airport has a population of approximately 60,000 and includes the political center of Cabo Delgado Province. The City of Pemba, as well as the airport, is located on a narrow peninsula separating the Indian Ocean from Pemba Bay, which has a single berth seaport, and is served by the national roadway system.

The Pemba Region has a strong tourism development potential in both its white sand and clear water beaches and inland areas. Within a few minutes from the airport, the new 5-star, 60-room Pemba Beach Hotel is located directly north of Wimbi Beach and has developed a marina for yachts and other pleasure craft. The immediate area also includes the Nautilus Bungalow Hotel as well as other hotels for middle class tourists. Offshore, the Quirimba Islands feature coral reefs, exotic marine wildlife and other maritime attractions.

The airport site is located on the West side of the peninsula and approximately 3 km to the Southeast of the city of Pemba. The airport is situated on a plateau approximately 100 m above sea level, which drops off steeply to the immediate North and the West of the airport facilities. The airport site is severely constrained due to the presence of the above-mentioned difference in elevation to the North and West and the National Highway to the East and the existing facilities occupy almost all of the available land area. Figures 2.1 and 2.2 indicate the location of the airport in relation to its surroundings.

Role

Pemba airport serves as the principal air transportation infrastructure of Cabo Delgado Province and point of access to the coastal area of northern Mozambique, especially the areas immediately surrounding the city of Pemba and the Quirimba Islands. Although the Pemba handles international flights within the Southern Africa region, notably to/from Johannesburg, Nairobi and Dar es Salam, it is classified at present as a "Principal Aerodrome" as opposed to an "International Airport" according to the system established by ADM for the purpose of establishing the schedule of airport charges.

Site Visit

Members of the AAROTEC Team visited Pemba airport on July 2 and 3, 2007, and inspected the facilities in the company of the Airport Manager, Antónia Fernandes, and the Civil Works Maintenance Technician, Mr. Kapoka. The results of this visit are incorporated in the following sections of this report.

Figure 2.1 Pemba Airport

Figure 2.2 Pemba Airport Surroundings

2.1.1 Existing Infrastructure

Airside Infrastructure

The existing infrastructure at Pemba airport is summarized in the following table.

Table 2.1: Pemba Airport Existing Airside Infrastructure

Coordinates	S 12:59.0; E 40:31.0
Elevation	101 m above sea level
Reference temperature	31.3 degrees Celsius
Runway #1	Main runway
ICAO Code	4C
Orientation	17/35
Dimensions	1,800 m x 45 m
Slope	0.2%
Surface	Asphalt
Surface conditions	Disintegration, construction joint depressions, pot-holes, edge erosion
Strength	PCN 24 F/A/X/U
Shoulders	No
Lighting	Yes
Taxiway	Perpendicular access taxiway
Dimensions	175 m x 23 m
Surface	Asphalt
Surface conditions	Disintegration, edge erosion
Shoulders	No
Lighting	Yes
Runway #2	Crosswind (secondary) runway)
Code	2B
Orientation	08/26
Dimensions	800 m x 45 m
Slope	NA
Surface	Asphalt
Surface conditions	Loose aggregate, pot holes, depressions
Strength	NA
Shoulders	No
Lighting	No
Commercial Apron	
Dimensions	80 m x 210 m
Surface	Asphalt
Surface conditions	Depressions, disintegration, oil spills
Shoulders	No
Lighting	Yes

The main runway 17/35 at Pemba Airport has no parallel taxiway. The geometry of the existing simple runway system presents no operating problems under present traffic levels. In the future, if needed, a taxiway loop at the south end of the runway would allow for more efficient aircraft operations.

Landside

The existing terminal building has a total floor area of approximately 1100 m^2 and is in good operating condition. The passenger processing areas are all on the ground floor, with arrivals and departures situated side by side. The building also contains offices for the airport administration, the aeronautical information services, airlines and other users on both the ground floor and a partial upper level. The building is surmounted by a control tower and cab.

Aircraft fuel is available from two suppliers. The Petromoc facility consists of two above-ground tanks for Jet A-1 with a capacity of 25,000 l each, protected by bermed dyke, and a small office. The BP facility consists of two underground tanks for Jet A-1 with a capacity of 22,730 l each and one above-ground tank for Avgas with a capacity of 20,000 l, all protected by a dyke, as well as a small office. Both facilities appear to be modern, clean and well maintained.

The electrical sub-station contains a step-down transformer, an emergency power generator and constant current regulators dating back 15 years. According to the airport administration, the runway lighting cables are not in ideal condition due to problems with the insulation and consequent increased resistance.

The airport is equipped with one fire-fighting vehicle, with a capacity of 6000 l of water and 800 l of foam and an ambulance. The fire hall is located adjacent to and directly North of the passenger terminal building, facing the aircraft parking apron.

Other airport facilities include a small air cargo warehouse located to the North of the passenger terminal complex, two general aviation hangars located at the Southern end of the landside complex, a small meteorological station (in rather poor condition) and car rental boutiques located along the landside access road.

Although the dimensions of the existing landside road system do not impose constraints for the management and flow vehicular of current traffic volumes, the access roads and vehicular parking areas need re-paving.

Operating Performance and Constraints

The site visit inspection indicated that extension of Pemba's main runway to the North is not feasible because there is a steep drop in the elevation of the natural terrain of almost a hundred meters. However, to the South the airport site is relatively flatter and leaves room for limited extension of the runway.

2.1.2 Status of On-going/Short-term Airport Development Projects

A number of studies and proposals involving Pemba airport have been undertaken by various agencies in recent years, including the following:

Mozambican Airport System Study (1998)

Aeroportos de Moçambique, E.P commissioned a study of the national airports system which was completed in May 1998 by Louis Berger International Inc. This exercise discussed Pemba airport as part of the total ADM system. It included forecast of air traffic for the system as a whole as well as for the individual airports, assessment of the facilities and investment requirements at each airport and assessment of the environmental, economic and financial implications of the proposed development program.

The 1998 Mozambican Airport Study also included a section (Appendix IV-A-6) devoted to an evaluation of the condition of the airside areas of Pemba airport. This exercise comprised a visual assessment, a photographic report, trial holes, hand CBR probes and field test results, laboratory tests, in situ density tests and deflectometer tests.

Comments

With respect to the air traffic forecasts at Pemba airport as presented in this report, the actual recorded traffic since completion of the report in 1998 far exceeds the projections of the Consultant. The results, therefore, are not applicable to the present exercise.

With respect to the evaluation of airside conditions at Pemba airport as presented in this report, subsequent studies as well as the on-site inspection preformed by the AAROTEC Team in July 2007 confirm the general validity of the Consultant's conclusions. Although the above-mentioned report was completed in 1998, based largely on work performed on 1997, the basic data on the airfield conditions provides a good data base for future work, bearing in mind that the facilities have continued to deteriorate since that date.

Business Prospectus for the Nacala Development Corridor Airport (2004)

With the aim of increasing private sector participation in the management of its transportation infrastructure, ADM commissioned a study aimed at granting concession rights to develop, modernize, rehabilitate, maintain, finance, operate, manage and exploit the "Nacala Airports Group" by the Louis Berger Group, Inc. As part of this exercise, the consultant prepared a Business Prospectus in May 2004 which was intended to be distributed to potential operators/investors. This document included, *inter alia*, assessments of the existing facilities, forecasts of air traffic and requirements for new investment at Nacala, Nampula and Pemba airports.

With respect to the airside facilities at Pemba airport, the Business Prospectus identified a number of specific infrastructure requirements, based on "Indicative Traffic Projections" which are discussed in Section 3.4.2 of the present report. According to the number of forecast aircraft movements at Pemba, the Business Prospectus determined that no major additions to the existing taxiways and aprons would be necessary in order to accommodate the traffic in 2024. With respect to runway length requirements, the Business Prospectus concluded that the main runway at Pemba would require an extension of up to 300 m in order to accommodate Code D passenger aircraft with

a 90% payload on the full range of regional routes and 900 m in the case of all-cargo aircraft with a 90% payload on these routes.

With respect to the landside facilities, the Business Prospectus identified that the passenger terminal facilities would have to expanded from the present 1,100 m² to 2,600 m² in 2010, 3,000 m² in 2015, 3,500 m² in 2020 and 4,000 m² on 2025, in order to accommodate the above-mentioned traffic forecast at a Category "C" Level of Service (LOS) as defined by IATA (assuming 10 m² per Peak Hour Passenger (PHP)

The report concluded that the highest priority airport infrastructure development needs at Pemba are as follows:

1. Runway pavement overlay,
2. Runway end safety areas,
3. Some visual aids for navigation such as signaling, markings and aeronautical beacon,
4. Upgrade emergency services,
5. Perimeter fence and road.

The following table provides a more complete list of the compliance requirements and investment needs at Pemba airport as recommended in the NDC Airports Concession Business Prospectus:

Table 2.2: NDC Airports Group Business Prospectus, Pemba Airport Compliance Requirements and Investment Needs

Runway 17/35	
Runway resurfacing	Asphalt 6 cm
Runway end safety areas	Asphalt 6 cm; 90 m x 90 m both thresholds
Taxiway	
Taxiway resurfacing	Asphalt 6 cm
Apron	
Commercial apron resurfacing	Asphalt 6 cm
Apron shoulders	Asphalt 6 cm; 3.5 m wide
Visual aids	
Aeronautical beacons	Aerodrome beacon
Indicators and signage	Wind direction and signaling lamp
Marking	Vertical and horizontal painting
Other	
Perimeter fence	
Perimeter road	
Access road	Asphalt 6 cm
Roads and parking in front of terminal	Asphalt 6 cm
Terminal building	
Terminal building remodeling	
Furniture, fixtures and equipment	
Fire fighting equipment	

Technical infrastructure
Wastewater treatment plant
Incinerator

As part of the NDC Business prospectus, the Consultant prepared preliminary estimates of the investment needs of the above-mentioned prioritized development plan for Pemba airport, based on local unit costs, including engineering and capital costs.

Table 2.3: NDC Airports Group Business Prospectus, Pemba Airport – Summary of Capital Investment Program

	Initial Investment Requirements (USDx1000)				Repavement (USDx1000)	
	2005	2006	2007	Total	2014	2024
Airside	1,154.1	1,538.7	1,154.1	3,846.8	999.0	999.0
Landside	191.9	255.8	191.9	639.5		
Technical Infrastructure	126.8	169.0	126.8	422.5		
Total	1,472.7	1,963.5	1,472.7	4,908.9	999.0	999.0

Conceptual Design for the Upgrade of the Pemba Airport Facilities (2007)

Aeroportos de Moçambique, E.P. commissioned studies aimed at a major expansion and upgrade of the Pemba airport facilities by BKS Global Moçambique Lda. which were completed in 2007. These involved engineering designs for the airside facilities (Reference no. 25) and architectural plans for a new passenger terminal and air traffic control tower (Reference no. 26).

The BKS airside study included an assessment of the existing pavements through various intrusive tests, sampling and mechanical measurements, as well as a detailed visual inspection. This exercise concluded that although the structure of the main runway is in sound condition with only a few localized failures and potholes, the surface is in poor condition due to raveling of the aggregate due to brittleness of the binder and requires replacement. It also concluded that the surface of the secondary runway shows severe aggregate loss due to brittleness of the asphaltic binder with several serious failures and potholes forming as a consequence. The principal form of distress of the aircraft parking apron was found to be severe aggregate loss of the surface layer for the same reason, with some localized potholes and failures due to cracking of the surface and subsequent penetration of water.

According to the airside study, the existing main runway pavement has sufficient bearing strength to accommodate the aircraft loading of the B737-type aircraft associated with the current domestic and regional air traffic but not that of the A340-500 which was assumed to be the Critical Aircraft for Pemba airport in the event that the airport would eventually serve intercontinental traffic. The aircraft parking apron, however, was determined have insufficient strength to accommodate the current traffic and requires reinforcement in the short term order to be able to prevent failure.

The airside study also included a recommendation to extend the main runway from its present length of 1800 m to a total length of 3295 m, based on the hypothesis that the airport would handle regular flights of A340-type aircraft on intercontinental routes.

ADM proposed to divide the project into three works contracts, namely:

- a design-and-construct contract for a new terminal building and control tower;
- a design-and-construct contract for the rehabilitation and upgrading of the existing terminal building into a new cargo terminal building;
- a construction contract for the rehabilitation and upgrading of the airside facilities, including among others the rehabilitation of existing pavements, lengthening the main runway, developing a new commercial airline parking area and construction of associated taxiways, all navigational elements and all storm-water management and erosion protection elements.

Comments

Although Pemba airport requires expansion to be able to continue to serve air passengers traveling to/from the area, the AAROTEC Team feels that the proposed development of the facilities should be phased to coincide with the future growth and demand in order to avoid expensive over-building. The construction phasing should be decided as a function of the phasing of the required development to accommodate confirmed demand. Additionally, the airport site is severely limited because the surrounding topography drops off steeply at the West side of the airfield and at the North runway end. Therefore the constraints on the ultimate design of the airport at this site should be carefully considered before a tremendous investment is made at the present site. The appropriate ultimate design capacity may thus be limited by the site constraints.

With respect to the geometric design of the airfield as proposed in the 2007 Pemba Airport Facilities Upgrade Conceptual Design, the AAROTEC Team has the following observations:

- Although the main runway should be expanded to accommodate the likely evolution of air traffic demand in the Pemba area, consideration must be given to the deep canyon to the North end of the runway to provide for a Runway Safety Area or an offset threshold line for landing on runway 35.

- The critical aircraft should be scaled back to a maximum load capacity of approximately 200 passengers since the local accommodation such as hotel rooms and beds is inadequate to service a larger aircraft. In the long-term future a larger aircraft may be considered but smaller aircraft will be more appropriate for service to European cities for the foreseeable future. In addition, the future and current aircraft in production are more powerful, more fuel efficient and lighter so that they can take off on a shorter airfield and travel further with more passengers. Any calculations for runway length sizing for international flights should consider the advancements in modern aircraft.

- The proposed parallel taxiway is not needed at this time because there are practically no delays forecast for planes waiting to take off or land.

- The runway extensions should include a turn-around and holding area at each end of the runway for aircraft use until the number of aircraft activities warrants a parallel taxiway.

With respect to pavement engineering as proposed in the 2007 Pemba Airport Facilities Upgrade Conceptual Design, the AAROTEC Team recommends that the determination of the structural strength of the runway and the parking areas be delayed until the extent of the appropriate development for the Pemba airport site is decided.

With respect to storm-water management: as proposed in the 2007 Pemba Airport Facilities Upgrade Conceptual Design, the AAROTEC Team has the following observations:

- In the conceptual design only the Rational Method was used to determine the flood peaks and the design flood. It is, however, good practice to use more than one method in order to assess the flood peaks properly and it is therefore recommended that at least one other method also be used and that its results be compared with that of the Rational Method.

- Only rectangular channels were considered for the 1:10 year peak discharges. It is recommended that trapezoidal channels also be investigated to establish whether this option will not be more economical.

- Sub-surface drainage for the channels must be designed in order to deal with groundwater and its associated pore pressures on the canal structures.

- Some flood attenuation might be required before the runoff is diverted into a culvert type of structure for some of the channels. It is recommended that this be properly assessed in the preliminary design.

- Five new concrete-lined channels are proposed to accommodate the macro storm-water management of the Pemba Aerodrome.

With respect to geo-technical engineering as proposed in the 2007 Pemba Airport Facilities Upgrade Conceptual Design, the AAROTEC Team recommends that the need for bank stabilization may be reduced once it is decided to respect the natural limitations of the site for an international airport and review the need for a parallel taxiway.

With respect to navigational aids as proposed in the 2007 Pemba Airport Facilities Upgrade Conceptual Design, the AAROTEC Team has the following observations:

- Once a determination is made regarding the extent of the expansion of the airport, the runway placement and extensions can be properly determined.

- The runway should not be extended North to the edge of the canyon to allow for

simple lighting placed upon the runway safety area, as pointed out in Section 5.3.3 of the Nacala Development Corridor Airports Group Business Prospectus. Elevated lighting is a severe and costly maintenance problem that should be avoided if possible.

With respect to other airport installations as proposed in the 2007 Pemba Airport Facilities Upgrade Conceptual Design, the AAROTEC Team has the following observations:

- The proposed height of the control tower should be reviewed in the light of our recommendations regarding the limits on the length of the runway.
- The terminal expansion may require an elevated departure lounge because of space constraints upon the surrounding area.

LAM Runway Pavement Assessment (2007)

Faced with continuing excessive wear on aircraft tires, the national airline LAM recently commissioned an assessment of runways at the ADM airports which it serves, including Pemba among others. This assessment, completed by the Goodyear Tire Company in 2007 concluded that the condition of the runway surface at Pemba is seriously deteriorated and represents a significant cause of the undue damage to the tires of the LAM fleet.

Selected photographs of the runway surface extracted from the Goodyear report were provided to the consultants by LAM and are presented in the Appendices to the present report. They show serious rutting of the surface and loss of the asphaltic matrix holding the aggregate in place, thus confirming the conclusions of the above-mentioned BKS studies of 2007 and the on-site observations of the AAROTEC Team in July 2007.

2.1.3 Staffing/Operations

ADM operates Pemba airport with a total employment of 32 persons, including one (1) airport manager, two (2) administrative staff, twenty-three (23) operations employees and 6 maintenance workers.

2.2 Nacala Airport

Location

The existing Nacala airfield is located in the Province of Nampula near the city of Nacala and within the limits of a large active military base. The immediate catchment area of the airfield has a population of approximately 100,000 and is a major_economic center of Nampula Province and northern Mozambique. The city of Nacala is located at the base of a peninsula separating Nacala Bay from the Indian Ocean.

Nacala is also the site of an important deep ocean port, which is said to be the finest deep water harbor in Africa, plugging to almost 200 m. It is served by the national railway and roadway systems and an international rail line which connects it to a vast hinterland extending beyond Mozambique to Malawi, Zambia and Zimbabwe. Nacala bay is linked to the Indian Ocean through a wide channel with more than half a kilometer in width and 60 m in depth. It does not require dredging and is open to ships at all times with any tide. The Finnish Government recently provided funding for a major upgrading of the port facilities.

The Government of Mozambique is developing a Special Economic Enterprise Zone in the Nacala Region, which is already attracting significant new business activity linked to the port operations.

The Nacala region is also considered to have a strong tourism development potential in both its beaches and inland areas. Nearby Mozambique Island has been declared an official World Heritage site by UNESCO.

The airport site is located on the West side of the peninsula and approximately 15 km to the North of the center of the City of Nacala. The airport is situated on an extensive area of well-drained flat land. For the purposes of airport development, the site is virtually unconstrained. A large area immediately to the South of the existing military base is available for development of civil airport facilities, with ample land for expansion. Figures 2.3 and 2.4 indicate the location of the airport in relation to its surroundings.

Role

Although the Nacala airfield receives some occasional non-scheduled civilian general aviation flights, it is classified officially as a Military Airport and, as such, offers only restricted access to public air traffic.

Site Visit

Members of the AAROTEC Team visited the Nacala air force base on July 4, 2007, and inspected the airfield facilities in the company of the Base Commander, Colonel Como, and members of his staff, as well as Mário Jorge Mendonça, the head of the provincial tourism and hotel operators association. The results of this visit are incorporated in the following sections of this report.

2.2.1 Existing Infrastructure

Construction of the Nacala airfield facilities was completed in 1969 at the same time as the military base.

Figure 2.3 Nacala Airport

Figure 2.4 Nacala Airport Surroundings

Airside Infrastructure

The existing airside infrastructure at Nacala airport is summarized in the following table.

Table 2.4: Nacala Airport Existing Airside Infrastructure

Coordinates	S 14:28.8; E 40:42.5
Elevation	125 meters above sea level
Reference Temperature	29 degrees Celsius
Runway	
ICAO Code	4D
Orientation	01/19
Dimensions	2,500 m x 45 m
Slope	NA
Surface	Asphalt
Surface conditions	Cracks and loose materials
Strength	NA
Shoulders	No
Lighting	No
Runway centerline to taxiway centerline distance	210 m
Taxiway	Full parallel
Dimensions	2,500 m x 23 m
Surface	Asphalt
Surface Conditions	Cracks and loose materials
Shoulders	No
Lighting	No
Civil aviation apron	
Dimensions	100 m x 120 m
Surface	Asphalt
Surface Conditions	Cracks and loose materials
Shoulders	No
Lighting	No
Military aviation aprons (2)	
Dimensions	285 m x 85 m and 285 m x 75 m
Surface	Asphalt
Surface Conditions	Cracks and loose materials
Shoulders	No
Lighting	No

The airside configuration of the airport has the general geometric characteristics of an ICAO Code D airport. Its runway length has the capacity to operate Code C aircraft with 100% payload and Code D aircraft with 90% payload. The airfield has no visual aids for navigation

The existing airside pavements show visible distresses and deteriorations such as alligator cracks and superficial loose material. All pavement areas are in need of asphalt overlays.

Landside Infrastructure

The existing landside infrastructure consists of the following elements:

<u>Multi-purpose Building</u>

A Multi-Purpose Building measuring approximately 192 m^2 is located adjacent to the existing aircraft parking apron. It is currently used for meetings with theater-style seating and has a capacity of approximately 30 people. It is a simple utilitarian shelter constructed of plastered concrete masonry walls, concrete floor and a sloped, wooden roof structure supported by iron railroad rails functioning as rafters. The roof structure is sagging and should be strengthened with additional supporting roof rafters if this building is to continue in use.

Military Aircraft Hangar

The Military Base contains multiple buildings and the northwestern apron contains a large metal hangar, measuring approximately 16,000 m^2. It is constructed of a steel frame and metal wall cladding and exhibits an advancing degree of corrosion.

Airport Roadways

The main airport access road and the interior road which leads to the civil aviation apron are unpaved dirt roads. Although, the dirt surfaces remain compacted during the dry season, the surfaces are muddy during the rainy season.

Air Traffic Control Tower

The Air Traffic Control Tower structure, located adjacent to the central access taxiway, is approximately 12 m high and measures 10 m^2 at its base. The tower is constructed of plastered, concrete masonry walls, concrete floors and a sloped metal roof. It is inoperative at present; all windows have been destroyed and only the concrete structure has remained standing. Although, the building appears to be structurally sound, it is inoperative at present.

Fuel Storage Area

The Fuel Storage Area is located due south of the Civil Aviation Apron, across from the airport's Main Access Road. The Fuel Storage Area contains an underground storage tank with a 60,000 l capacity which has been abandoned in place and is not usable.

Operating Performance and Constraints

The airport contains large expanses of open land, which can provide for unconstrained development of civil aviation facilities. If the airport is to be used for civilian commercial air traffic, even under minimal non-precision approach procedures, all lights, indicators and markings required by ICAO will have to be installed.

With respect to the landside, there are no civil aviation facilities at Nacala

Airport at present. If the airport is to be used for civilian commercial air traffic, it will need all infrastructure facilities, such as access roads, vehicular parking areas, a terminal building, fire fighting equipment and installations, electrical power, water, telephone lines, a new fuel farm, maintenance areas, etc.

2.2.2 Status of On-going/Short-term Airport Development Projects

Business Prospectus for the Nacala Development Corridor Airport (2004)

As described in Section 2.1.2 of the present report, Aeroportos de Moçambique, E.P. commissioned a study aimed at granting concession rights to develop, modernize, rehabilitate, maintain, finance, operate, manage and exploit the "Nacala Airports Group" by the Louis Berger Group, Inc. As part of this exercise, aimed at increasing private sector participation in the management of its transportation infrastructure, the consultant prepared a Business Prospectus in May 2004, which was intended to be distributed to potential operators/investors. This document included, *inter alia*, assessments of the existing facilities, forecasts of air traffic and requirements for new investment at Nacala; Nampula and Pemba airports.

With respect to the airside facilities at Nacala airport, the Business Prospectus identified a number of specific infrastructure requirements, based on "Indicative Traffic Projections", which are discussed in Section 3.4.2 of the present report. According to the number of forecast aircraft movements at Pemba, the Business Prospectus determined that no major additions to the existing taxiways and aprons would be necessary in order to accommodate the traffic in 2024. With respect to runway length requirements, the Business Prospectus concluded that the main runway at Nacala would require no extension in order to accommodate Code D passenger aircraft with a 90% payload on the full range of regional routes, but an extension of approximately 200 m in the case of all-cargo aircraft with a 90% payload on these routes. With respect to apron requirements, the Business Prospectus concluded that the Nacala airport would require 2 parking stands in 2010 and 3 in 2024.

With respect to the landside facilities, the Business Prospectus identified that passenger terminal facilities would have to build in order to accommodate the above-mentioned traffic forecast, since no facilities exist at present. Based on providing a Category "C" Level of Service (LOS), as defined by IATA, (assuming 10 m^2 per Peak Hour Passenger (PHP), Nacala would require 2,500 m^2 in 2010, 3,100 m^2 in 2015, 3,900 m^2 in 2020 and 4,500 m^2 on 2025,

The report concludes that the highest priority airport infrastructure development needs at Nacala are as follows:

1. Runway pavement overlay
2. Runway shoulders
3. Runway end safety areas
4. All visual aids for navigation

5. Equipment and electrical installations
6. Emergency services
7. Air traffic control tower and associated communications equipment
8. Perimeter fence and perimeter road

The following table provides a more complete list of the compliance requirements and investment needs at Nacala airport as recommended in the NDC Airports Concession Business Prospectus:

Table 2.5: NDC Airports Group Business Prospectus, Nacala Airport Compliance Requirements and Investment Needs

Runway 01/19	
Runway resurfacing	Asphalt 10 cm
Runway end safety areas	Asphalt 6cm; 90 m x 90 m both thresholds
Runway shoulders	Asphalt 6 cm; 7.5 m both sides of runway
Taxiway	
Taxiway resurfacing	Asphalt 10 cm
Apron	
Access taxiway resurfacing	Asphalt 10 cm
Access taxiway shoulders	Asphalt 6 cm ; 5 m both sides of taxiway
Commercial apron resurfacing	Asphalt 10 cm
Apron shoulders	Asphalt 6cm; 7.5 m wide
Visual aids	
Approach lights	Simplified approach lighting system
Visual approach indicator	PAPI
Runway threshold/end lights	Red-green
Runway edge lights	White
Taxiway edge lights	Blue
Indicators and signaling	Wind direction and signaling lamp
Marking	Vertical and horizontal painting
Equipment and installations	
Emergency generators	
Rescue and fire fighting equipment	Civil works; Cat 7 equipment
Tow tug	Ramp tractor for Code D airplanes
Ground service equipment	Loader, baggage carts, conveyor belts, pax steps, potable water, toilet service, ground power unit, catering, etc.
Other	
Perimeter fence	
Perimeter road	
Access road	1,600 m from existing public road
Roads and parking in front of terminal	
Terminal building	
New terminal building	4,000 m^2
Furniture, fixtures and equipment	
Technical infrastructure	
Air traffic control tower	Rehabilitation of existing structure

ATC equipment	
Electrical substation	Transformers 300 Kw
Emergency generators	1 of 250 Kva + 1 of 100 Kva
Water supply and treatment plant	
Wastewater treatment plant	
Telephone supply	Microwave access; 100 lines
Fuel farm	
Incinerator	

As part of the NDC Business Prospectus, the Consultant prepared preliminary estimates of the investments needs of the above-mentioned prioritized development plan for Nacala airport, based on local unit costs, including engineering and capital costs.

Table 2.6: NDC Airports Group Business Prospectus, Nacala Airport – Summary of Capital Investment Program

	Initial Investment Requirements (USDx1000)				Repavement (USDx1000)	
	2005	2006	2007	Total	2014	2024
Airside	2,317.1	3,089.4	2,317.0	7,723.5	1,777.0	1,777.0
Landside	1,453.8	1,938.4	1,453.8	4,845.9		
Technical Infrastructure	2,844.0	3,792.0	2,844.0	9,480.0		
Cargo	52.8	70.4	52.8	176.0		
Total	6,667.6	8,890.2	6,667.6	22,225.5	1.777.0	1.777.0

Comments

Chapter 6 (Investment Needs and Required Infrastructure) of the NDC Airports Group Business Prospectus is useful as a starting point and reference for the current study. The detailed breakdown of costs in Appendix 5 (Cost Estimates of Investment Needs), however, was not available to the AAROTEC Team at the time of writing this report and therefore it was not possible to assess the pertinence of the cost summary. This portion of the report should be obtained for future analysis. Chapter 6 also mentions that two alternative designs were selected for the new Nacala airport passenger terminal building; however, neither design was available for review at this time and should be retrieved for future evaluation and utilization. Should Nacala be selected for priority development as an international airport over Pemba this chapter will be very useful as a guideline for the future work.

The above-mentioned proposed improvements at Nacala were based on passenger projections that justified the need for these improvements. In this context it should be noted that the forecast for Nacala passenger growth is twice that for Pemba through the year 2024; thus the projected capital cost for Nacala was over USD22 million while the capital cost for more limited improvements at Pemba was only USD5 million.

Geo-technical Investigations

In 2007 ADM commissioned the firm of BKS Global Moçambique Lda. to perform a series of geo-technical tests of the Nacala airfield. These were published in the form of a report dated April 2007, entitled Aeroporto De Nacala Ensaios de Carga com Deflectómetro de Impacto (FWD) and were intended to serve as basis for the eventual design for the rehabilitation of the existing pavement structures. At present they represent more or less raw data which will be made available to the designers and builders of projected facilities.

Deflectometer tests were made along the length of the runway, the parallel taxiway, the connector taxiways and the aircraft parking apron. In addition to the published report, the results are also available in the form of spreadsheets for ease of subsequent calculations and determinations.

2.2.3 Staffing/Operations

The Mozambique Air Force (FAM) operates the Nacala air base. The total number of soldiers assigned to the operation and maintenance of the existing facilities is not known. In view of the fact that the airfield is not in use for commercial flights; however, this is not important since the eventual change in the status of the airport would require a completely new management structure in any case.

2.3 Vilankulos Airport

Location

Vilankulos is located approximately 700 km from Maputo, Mozambique, Vilankulos is close to the Bazaruto Archipelago, the chain of islands, which consist of five main islands. The coast line of Vilankulos and the chain of islands are well established for tourism and have been a favorite destination of holidaymakers since before the war. Vilankulos is a lush, tropical paradise with a remarkable Indian Ocean coastline of white sand beaches. There are pristine reef systems and beneath the ocean lies an amazing marine life. Vilankulos is known for the world-class big game fishing, snorkeling and scuba diving.

Vilankulos has experienced a significant increase in passenger traffic due to tourism in the area in last few years. Many resorts, hotels and restaurants have been established in the beaches near Vilankulos. This has attracted a large number of tourists. Historically traffic to Vilankulos has been regional (tourists from South Africa), fifty (50% percent of the current traffic is comprised of non-scheduled charter flights, not only regional, but also a lesser per cent are international tourist.

Role

The Terms of Reference of the present study identified Vilankulos airport as being open to the possible diversion of air traffic to airports in the North of the country. It was concluded early during the initial and orientation visit that the Vilankulos Airport would not be selected to expand their facilities for the requirements of the study. This was

concluded after having analyzed the traffic patterns and after the meetings with economic agencies and tourism operators as well as ADM.

It was thought that the proposed investments in improved airport facilities at Pemba and/or Nacala might have an impact on the expected levels of traffic at Vilankulos as well as other airports in the ADM system. The study further concluded that Vilankulos airport would not lose passengers that presently make up the air traffic due to the effects of expanded facilities at Pemba or Nacala. The increased traffic will be international passengers and these flights will originated in Europe and the Mid-East for the expanded airport of either Nacala or Pemba. These two airports are located in the northern region of Mozambique, and Vilankulos is located in the south region of the country.

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SECTION 3: FORECAST OF DEMAND

The present section of this report provides a review of existing forecasts and a presentation of relevant scenarios for the evolution of air traffic at the airports under consideration over the next 20 years. This task includes, *inter alia*, the establishment of a coordinated data base of forecast airport activities, which will constitute the starting point for the planning and sizing of airport facilities as well as the determination of requirements for connections to the surrounding roads and services infrastructure and the assessment of environmental, social and economic impacts. The air traffic forecasts will also provide critical information to perform technical, financial, and economic assessments of the airport development programs and constitute a basis for investment decisions on the part of the Government. It provides analysis of historical trends of Mozambique and regional macroeconomic variables (population, GDP growth, growth of the tourism industry, exports and imports growth etc.)

3.1 Analysis of Historical Air Traffic Data

3.1.1 Regional (Southern Africa) Air Traffic

In order to provide background for the forecast of air traffic at the airports under consideration, the AAROTEC Team consulted a variety of international sources which record data from airports in the Southern Africa region.

ICAO Aviation Statistics Data Base

The International Civil Aviation Organization (ICAO) collects data from member countries on key indicators of air traffic. The AAROTEC Team conducted a search of the ICAO aviation statistics data bank for information on aviation activity in the Southern Africa region. Unfortunately, ICAO relies entirely on data as provided by the countries; thus the information available in the ICAO data bank is (a) incomplete and (b) un-audited. Furthermore, the region has been subject to a number of natural and political disruptions over the past two decades which have had an effect on the evolution of air traffic, potentially producing anomalous results at certain times and for certain countries. Taken together, however, the ICAO data bank provides an overview of the evolution of the regional market in recent years, albeit with certain reservations.

In order to mitigate the effects of the above-mentioned deficiencies in the ICAO data, we proceeded to aggregate the available traffic figures for the Southern Africa region to the extent possible by using only those airports for which a consistent time series could be found. This resulted in the summary of a selected number of airports in the region as presented in Table 3.1, which excludes those operated by the Airports Company of South Africa (ACSA). The table indicates that the evolution of air traffic in the region has been very erratic over the past few years. Annual growth rates varied from a high of

+19.7% to a low of –24.7% for the period between 1992 and 2003 (the only years for which consistent and comparable data was available. The average annual growth rate over this period was only a little less than 3%. It should be noted, however, that the data collected by ICAO does not include comparable figures

for the single largest generator of air traffic in the region – the Republic of South Africa – nor does it include Mozambique.

Table 3.1 Southern Africa Air Traffic Statistics (ICAO Aviation Statistics Data Bank)

	Total Commercial Air Transport Passengers								
	Botswana		Lesotho	Madagascar	Malawi	Mauritius	Namibia	sub-total	percent
	Khama	Maun	Moshoeshoe	Ivato	Lilongwe	Rangoolam	Kutako		change
1992	172,807	62,397	33,682	325,662	226,319	976,406	258,373	2,055,646	
1993	160,757	59,762	27,050	363,023	211,575	1,059,414	306,536	2,188,117	6.4%
1994	184,179	82,853	32,951	446,314	214,590	841,233	320,711	2,122,831	-3.0%
1995	182,894	93,305	32,165	475,894	195,805	1,181,947	378,563	2,540,573	19.7%
1996	181,629	105,605	31,379	506,947	181,587	1,319,519	392,386	2,719,052	7.0%
1997	174,815	127,544	29,256	573,115	184,887	1,459,996	429,181	2,978,795	9.6%
1998	189,886	115,101	31,448	605,323	185,096	1,505,212	470,534	3,102,600	4.2%
1999	205,871	129,007	25,945	661,372	168,302	1,596,641	490,801	3,277,939	5.7%
2000	224,794	147,195	28,613	689,210	175,915	1,783,848	481,000	3,530,575	7.7%
2001	224,385	148,954	28,686	699,074	168,739	1,819,136	379,327	3,468,301	-1.8%
2002	242,513	143,480	28,716	638,190	149,162	1,896,307	404,759	3,503,127	1.0%
2003	254,542	120,036	28,746	543,395	150,511	1,034,675	506,077	2,637,982	-24.7%
							Average annual growth rate		2.89%

note: some data has been extrapolated from partial annual totals

Airports Company of South Africa (ACSA)

Data provided by Airports Company of South Africa (ACSA) constitute the most complete and reliable time series of key air traffic indicators in the Southern Africa region. ACSA is also the dominant airport operator in the region in terms of traffic throughput, with total annual traffic of almost 33 million passengers in fiscal year 2006/2007, far exceeding the total of all other airports in the region. In addition, ACSA operates airports at both ends of the spectrum: a large international hub facility at Johannesburg and smaller tourism-oriented sites such as Pilanesberg. Finally, the economy of Mozambique is more closely tied to that of South Africa than to any of the other countries in the region. As a result of these factors, the AAROTEC Team believes that the traffic data recorded by ACSA constitute a more reliable basis of comparison than that compiled by ICAO.

Table 3.2 provides an overview of air traffic at the ACSA airports for the period 1999/2000 to 2006/2007. Traffic grew at an average annual growth rate during this period of almost 8% for the ACSA system as a whole.

Table 3.2 ACSA Total Annual Air Traffic (passengers X 1000)

	Jo'burg	Cape Town	Durban	Bl'mfontein	E London	George	Kimberley	P. Elizabeth	Upington	Pilansberg	sub-total	
FY99/00	10,915,553	4,545,965	2,471,707	213,364	360,796	248,220	77,508	850,716	23,838	25,627	19,723,304	
FY00/01	11,271,957	4,591,809	2,487,308	212,681	341,787	249,300	80,628	851,047	22,645	28,974	20,138,136	2.1%
FY01/02	11,391,196	4,733,116	2,435,873	202,245	338,434	249,398	83,199	833,279	25,153	22,302	20,314,195	0.9%
FY02/03	12,368,176	5,100,441	2,607,688	214,740	362,324	288,571	87,384	890,338	28,616	25,243	21,973,521	8.2%
FY03/04	12,133,635	5,445,760	2,842,347	213,852	371,118	360,335	86,820	985,396	27,704	21,500	22,488,467	2.3%
FY04/05	14,505,871	6,198,843	3,202,194	227,085	445,366	462,159	90,725	1,095,136	26,552	17,392	26,271,313	16.8%
FY05/06	16,027,147	6,820,840	3,691,480	251,395	586,532	570,253	102,636	1,300,974	28,622	7,486	29,387,365	11.9%
FY06/07	17,704,677	7,500,551	4,251,594	349,310	691,548	573,077	114,057	1,435,248	33,127	1,517	32,654,706	11.1%
Average annual growth rate												**7.61%**

3.1.2 National Air Traffic

Data provided by ADM demonstrate that total air traffic in Mozambique has experienced strong and sustained growth over the past twelve years for all of the standard indicators of aviation activity: passengers, aircraft movements, air cargo and mail. In particular, passenger flows have increased from 523,500 in 1995 to 1,363,000 in 2006; aircraft movements from 34,100 in 1995 to 51,900 in 2006; air cargo and mail combined from 5,900 tons in 1995 to almost 13,400 tons in 2006. Table 3.3 summarizes the evolution of these indicators over this period.

Table 3.3: Evolution of Total ADM Annual Air Traffic Indicators 1995-2006

Year	Passengers		Aircraft Movements		Cargo + Mail (tons)	
1995	523,519	-	34,146	-	5,928	-
1996	519,978	-0.7%	32,814	-3.9%	5,830	1.7%
1997	576,232	10.8%	36,800	12.1%	6,637	16.1%
1998	597,783	3.7%	36,645	-0.4%	5,824	12.2%
1999	689,645	15.4%	40,916	11.7%	7,032	20.7%
2000	779,075	13.0%	47,776	16.8%	13,813	96.4%
2001	793,015	1.8%	42,723	-10.6%	10,116	-26.8%
2002	829,403	4.6%	42,005	-1.7%	7,014	-30.7%
2003	850,453	2.5%	41,046	-2.3%	7,804	11.3%
2004	956,132	0.7%	47,289	15.2%	9,535	22.2%
2005	1,248,970	30.6%	53,850	13.9%	10,870	14.0%
2006	1,362,997	9.1%	51,867	-3.7%	13,386	23.1%
Average growth rate		8.3%		4.5%		14.6%

Source: ADM-GPPD

The resulting average annual growth rates over this period were 8.3% for passengers, 4.5% for aircraft movements and 14.6% for air cargo and mail combined. Although the historical figures show some variation in the pattern of growth over this period, the general trend indicates a strong progression of the principal air traffic indices, especially in the case of total passengers and combined air cargo and mail, which constitute the main drivers of aviation activity.

3.1.3 Individual Airports

In order to provide base data for the forecast of air traffic related to the proposed improvements at Pemba and Nacala, we analyzed the historical evolution of typical aviation activity indicators at the airports of Pemba and Nampula. As indicated previously in this report, we chose the latter airport for analysis since a portion of the traffic which now uses Nampula airport has its ultimate origin/destination in the Nacala area due to the fact that no other air service access is available to/from Nacala at present.

Pemba

Air traffic indicators at Pemba airport indicate very strong and sustained growth over the past decade. Passenger flows have gone from a mere 17,600 in 1995 to 90,500 in 2006 (i.e. an increase of over five times); aircraft movements from only 960 in 1995 to almost 6,300 in 2006; air cargo and mail combined from 260 tons in 1995 to over 840 tons in 2006. Table 3.4 summarizes the evolution of these indicators over this period.

Table 3.4: Evolution of Pemba Airport Annual Air Traffic Indicators 1995-2006

Year	Passengers		Aircraft Movements		Cargo + Mail (tons)	
1995	17,561	-	964	-	260	-
1996	16,811	-4.3%	1,332	38.2%	292	12.3%
1997	20,434	21.6%	1,487	11.6%	209	-28.4%
1998	20,201	-1.1%	1,456	-2.1%	204	-2,4%
1999	22,677	12.3%	1,578	8.4%	237	16.2%
2000	19,257	-15.1%	1,180	-25.2%	254	7.2%
2001	22,177	15.2%	1,357	15.0%	302	18.9%
2002	29,174	31.6%	1,892	39.4%	432	43.0%
2003	36,392	24.7%	2,388	26.2%	484	12.0%
2004	53,041	45.7%	4,142	73.5%	688	42.1%
2005	84,665	59.6%	6,276	51.5%	756	9.9%
2006	90,487	6.9%	6,267	-0.1%	843	11.5%
Average growth rate		17.9%		21.5%		12.9%

Source: ADM-GPPD

The resulting average annual growth rates over this period were 17.9 % for passengers, 21.5 % for aircraft movements and 12.9 % for air cargo and mail combined. Although, the historical figures show some variation in the pattern of growth over this period, the general trend indicates an extremely strong progression of the principal air traffic indices, especially in the case of total passengers and combined air cargo and mail, which constitute the main drivers of aviation activity.

With respect to monthly historical air traffic data at Pemba, the airport registered the following pattern of variation throughout the year in 2006, as shown in Table 3.5 below. The figures are based on statistics provided by the airport administration at Pemba.

Table 3.5: Monthly Variation of Traffic, Pemba Airport 2006

	Aircraft Movements	Total Enpl+Depl Passengers	Transit Passengers	International Passengers
January	457	5,023	2,553	372
February	430	3,956	2,049	405
March	382	3,768	1,907	479
April	529	5,063	2,479	552
May	559	4,651	2,028	734
June	440	4,823	1,830	629
July	575	7,850	2,281	606
August	676	6,835	1,618	734
September	588	5,786	2,198	589
October	584	5,301	2,094	609
November	485	5,018	2,067	566
December	551	6,598	2,426	674
Total	6,250	64,672	25,560	6,949

Source: Pemba Airport Administration

According to the above table, the peak period of the year takes place during the months of July and August and again in December.

Table 3.6: Pemba Airport Combined Airline Schedule (July 2007)

Airline		A/C ID	A/C type	ARR	DEP	Destination
LAM	Mon	TM 173	B737-200	11:40	12:20	Beira
	Tues	TM 463	B737-200	9:25	17:25	Nampula
	Tues	TM 462	B737-200	9:55	13:05	Nairobi
	Wed	TM 315	B737-200	12:10	12:50	Maputo
	Thur	TM 2452	B737-200	11:20	12:00	Dar es Salam
	Thur	TM 2453	B737-200	16:45	17:25	Nampula
	Fri	TM 314	B737-200	13:30	14:10	Nampula
	Fri	TM 175	B737-200	13:45	14:25	Beira
	Fri	TM 313	B737-200	12:00	12:45	Maputo
	Sat	TM 465	B737-200	19:10	20:10	Nampula
	Sat	TM 464	B737-200	11:55	12:25	Dar es Salam
	Sun	TM 319	B737-200		16:45	Jo'burg
	Sun	TM 312/5	B737-200	13:10	13:50	Maputo
Air Corridor	Wed	QC 5031	B737-200	8:40	9:10	Vilanculos
	Wed	QC 606	B737-200	18:25	18:55	Nampula
	Fri	QC 610.1	B737-200	17:45	18:15	Nampula
	Sun	QC 613.1	B737-200	8:40	9:15	Tete
S.A. Airlink	Wed	SA 8850/1	B737-200	12:40	13:25	Jo'burg
	Sat	SA 8850/1	B737-200	12:50	16:50	Jo'burg

Source: ADM and LAM

With respect to the hourly variation in air traffic at Pemba, the schedule of airline service provides the best indication of the distribution of passenger and aircraft movements throughout the day. The current schedule of commercial airline service at Pemba airport

as shown in Table 3.6 below, was compiled on the basis of information provided by the Pemba flight information office and the published schedule of the national airline LAM. It provides a basis for the determination of the likely demands on the key airport facilities: the runway/taxiway system, the aircraft parking apron and the passenger terminal.

The commercial airline service indicated in the above table comprises the predominant air traffic activity at Pemba (passengers and aircraft movements). According to this schedule, the heaviest traffic of the week occurs on Wednesdays, when the three airlines serving Pemba operate a total of four regular flights. Scheduled peak hours occur as follows:

- Tuesday morning: one LAM arrival at 09:25 and one LAM arrival at 09:55
- Wednesday mid-day : one LAM arrival at 12:10 and one SA Airlink arrival at 12:40
  one LAM departure at 12:50 and one SA Airlink departure at 12:40
- Friday mid-day: one LAM arrival at 13:30 and one LAM arrival at 13:45
  one LAM departure at 14:10 and one LAM departure at 14:25

The above table also provides an indication of the categorization of the traffic pattern at Pemba airport by airline and by trip origin/destination for both local and international airlines. Apart from this traffic, aviation activity at Pemba consists of some limited local and itinerant general aviation movements. No schedule information was available regarding this sector; therefore, it was not possible to indicate an hourly or monthly pattern of passenger volumes of aircraft movements for these flights.

This being said, interviews with operators at Pemba indicated that general aviation traffic at the airport is primarily related to (a) tourist activity, especially charter flights of small aircraft to/from the Quirimba Islands and other more remote destinations, and (b) resource development, essential support for the exploration and exploitation of mines and other sites. Analysis of disaggregated traffic data for 2006 provided by the ADM statistics group indicates the following breakdown of aircraft movements and passenger volumes and freight tonnage at Pemba for 2006:

Table 3.7: Pemba Airport Traffic Components (2006)

Aircraft movements	**Domestic**	Scheduled	1459	23.3%
		Non-scheduled	3954	63.1%
		Sub-total	**5413**	**86.4%**
	Regional	Scheduled	448	7.1%
		Non-scheduled	318	5.1%
		Sub-total	**766**	**12.2%**
	Others (a)		**88**	**1.4%**
	Total		**6,267**	**100%**
Passengers	**Domestic**	Embarked	28,155	31.1%
		Disembarked	28,112	31.1%
		Transit	17,626	19.5%
		Sub-total	**73,893**	**81.7%**

	Regional	Embarked	3,258	3.6%
		Disembarked	3,692	4.1%
		Transit	8,095	8.9%
		Sub-total	**15,045**	**16.6%**
	Others (a)		**1,549**	**1.7%**
	Total		**90,487**	**100%**
Freight+mail tonnage	**Domestic**	Scheduled	825	**97.9%**
		Non-scheduled	0	0%
		Sub-total	**825**	**97.9%**
	Regional	Scheduled	18	2.1%
		Non-scheduled	0	0%
		Sub-total	**18**	**2.1%**
	International	Scheduled	0	0%
		Non-scheduled	0	0%
		Sub-total	0	0%
	Total		**843**	**100%**

(a) includes non-commercial traffic (local flights, military services and aeroclubs)

As indicated in the previous table, general aviation represents an insignificant component of the total traffic at Pemba in comparison with commercial airlines in terms of both aircraft movements (1.4%) and passengers (1.7%).

Nampula

Nampula airport now serves as the only gateway to the Nacala region, even though it is approximately three hours away by road; therefore we examined the air traffic patterns at Nampula as part of our methodology for determining the forecast of air traffic at Nacala. Air traffic indicators at Nampula airport indicate strong and sustained growth over the past decade. Passenger flows have gone from 47,800 in 1995 to 141,600 in 2006 (i.e. an increase of almost three times); aircraft movements from 2,150 in 1995 to over 3,500 in 2006; air cargo and mail combined from 530 tons in 1995 to 1,340 tons in 2006. Table 3.8 summarizes the evolution of these indicators over this period.

Table 3.8: Evolution of Nampula Airport Annual Air Traffic Indicators 1995-2006

Year	Passengers		Aircraft Movements		Cargo + Mail (tons)	
1995	47,751	-	2,154	-	533	-
1996	47,213	-1.1%	2,310	7.2%	558	4.7%
1997	54,609	15.7%	2,983	29.1%	542	-2.9%
1998	51,460	-5.8%	2,405	-19.4%	493	-9.0%
1999	56,210	9.2%	2,447	1.7%	580	17.6%
2000	61,360	9.2%	2,192	-10.4%	555	-4.3%
2001	67,848	10.6%	2,653	21.0%	656	18.2%
2002	74,651	10.0%	3,090	16.5%	717	9.3%
2003	79,374	6.3%	2,821	-8.7%	668	-6.8%
2004	83,629	5.4%	4,050	43.6%	829	24.1%
2005	138,995	66.2%	4,200	3.,7%	869	4.8%

2006	141,608	1.9%	3,527	-16.0%	1340	54.2%
Average growth rate		11.6%		6.2%		10.0%

Source: ADM-GPPD

The resulting average annual growth rates over this period were 11.6% for passengers, 6.2% for aircraft movements and 10.0% for air cargo and mail combined. Although, the historical figures show some variation in the pattern of growth over this period, the general trend indicates a very strong progression of the principal air traffic indices, especially in the case of total passengers and combined air cargo and mail, which constitute the main drivers of aviation activity.

Conclusions

The historical air traffic statistics for Pemba and Nampula airports indicate a stronger rate of growth over the last decade than that of the ADM system as a whole. Passenger traffic at Pemba, in particular, grew at a rate over twice that of the total ADM passenger traffic during the same period. Aircraft movements at Pemba increased at almost four times the rate for the ensemble of ADM airports. Air traffic indicators at Nampula show a similar tendency, although, the difference in growth rates are not as striking.

3.2 National Tourism/Industry Development Plans

The Mozambique tourism product is unique in the Southern Africa region, especially the warm-water tropical beaches and islands in the Northern Coastal areas served by Pemba and Nacala airports. The potential of this asset, however, has only begun to be exploited. The Government of Mozambique has adopted two key instruments aimed at the sustainable development of the tourism industry as a motor for economic and social progress: the Tourism Policy and Implementation Strategy (Resolution no. 14 of April 4, 2003) and the Strategic Plan for the Development of Tourism in Mozambique. These documents identify the specific priority areas for intervention by the Government and the private sector. In particular, the Northern Coastal areas of Cabo Delgado and Nampula provinces were identified by the Strategic Plan for the Development of Tourism in Mozambique as the most exclusive destination in the country and selected as Type A/B Priority Areas for Tourism Investment (PATIs).

The areas served by both of the airports under consideration present excellent opportunities for well planned, integrated and sustainable tourism. Although, the lack of hotel and resort infrastructure is a critical limiting factor at present, the attributes of the region (white sand beaches, warm water, diving, deep sea fishing, historical monuments, colonial architecture, etc.) constitute significant factors which will drive development by the private sector. The key source markets in the short term are Portugal and South Africa and the countries already linked to the South Africa tourism market, such as US, UK, Netherlands, Germany, Italy and Spain.

3.3 Existing Forecasts

A number of forecasting exercises dealing specifically with Mozambican airports have been undertaken in recent years. In particular, the forecasts prepared in 2007 by the GPPM department of ADM for internal planning purposes and in May 2004 by the Louis Berger Group for the purpose of the Nacala Development Corridor Airport Group Concession Project provide relevant data for the present projections. In addition to these exercises, forecasts of air traffic prepared by key international organizations in the air transport industry provide a valuable indicator of the prospects for the likely evolution of demand in a given region. The following paragraphs present an overview of the existing forecasts relevant to the development of Pemba and Nacala airports.

3.3.1 ADM Forecasts

During the Inception Mission of the present study in July 2007, the GPPD group of ADM provided the AAROTEC Team with a series of forecasts of passengers, aircraft movements and air cargo at individual airports in Mozambique for the period from 2007 to 2020. The methodology used by GPPD/ADM involves the application of a linear regression technique based on historical traffic statistics for the period from 1997 to 2006, resulting in the addition of a constant increment of traffic in each year and a corresponding declining annual rate of growth in percentage terms. For the airports under consideration this gives the following figures:

Table 3.9: ADM Air Traffic Forecasts – Constant Per Annum Linear Growth Increment 2007 to 2020

Indicators	Pemba	Nampula	Total ADM System
Total Passengers	7830	8727	80134
Total A/C Movements	568.12	184.85	1618.2
Total Air Cargo tons	76.667	70.268	514.51
Total Air Mail tons	-0.0089	-0.8364	15.465

Since the aviation facilities at Nacala are managed by the Mozambique Air Force and are not open to public civilian use, the above-mentioned ADM forecasts do not include this airport.

3.3.2 Nacala Development Corridor Airport Group Concession Project Forecasts

The Business Prospectus for the Nacala Development Corridor (NDC) Airports Group Concession Project (Reference 24) includes a series of "Indicative Traffic Projections" for the airports of Pemba, Nacala and Nampula covering the period from 2004 to 2024. These are presented in the form of "optimistic", "most likely" and "pessimistic" forecasts of annual passengers (not including transits) for each airport. The "most likely" forecast for each airport is further detailed into passenger sectors (domestic, regional, intercontinental and transits) and aircraft movements by sector, as well as average

passenger loads per flight for each airport. For the 20-year period covered by these Indicative Traffic Projections, average growth rates for total annual passengers at the three airports under consideration are as follows:

Table 3.10: Indicative Traffic Forecasts – Nacala Development Corridor Airport Group Concession Project Business Prospectus

Airport	Optimistic Forecast	Most Likely Forecast	Pessimistic Forecast
Pemba	11.5%	8.9%	6.5%
Nampula	5.5%	3.2%	0.7%
Nacala	15.9%	12.4%	10.9%

Pemba

It should be noted that the actual number of air passengers recorded at Pemba airport between the years of 2004 and 2006 have already exceeded these projections by an average of over 89% in comparison with the "most likely indicative forecast" as presented in the NDC Airports Concession Business Prospectus, as demonstrated in the following table.

Table 3.11: Pemba Airport – Comparison of Actual Recorded Air Traffic versus Forecast Air Traffic from NDC Airports Concession Business Prospectus (annual passengers – not including transits)

	Actual Recorded Volume	Most Likely Forecast	Percent Difference
2004	53,041	32,940	61%
2005	84,665	39,790	121%
2006	90,487	48,700	86%

To put this comparison into context, the passenger volume recorded at Pemba airport in 2006 corresponds to the projected air traffic for the 2013-2014 period in the "most likely indicative forecast" of the NDC Airports Concession Business Prospectus.

Nacala and Nampula

The forecast of air traffic at the proposed Nacala civilian airport, according to the NDC Airports Concession Business Prospectus, is based on the assumption that a portion of the traffic which presently uses Nampula airport would begin to use the new facilities at Nacala starting in 2006. This would correspond to the hypothetical opening of the airport to scheduled civilian flights and would involve the progressive shift of a traffic increment from Nampula to Nacala over a period of two years. In the NDC Airports Concession Business Prospectus "most likely indicative forecast", the magnitude of this increment corresponds to approximately 25% of the forecast traffic at Nampula in the first year and 33% in the second year. This in turn corresponds to a total shift, after two years, of approximately 50% of the traffic which, otherwise, would have passed through Nampula airport.

This assumption regarding the percentage of traffic presently using Nampula which would use Nacala if airport facilities were available at the latter was based on the following factors: (1) interviews with economic and tourism operators; (2) comparison of the relative populations, economic generators and tourist attractions of the areas directly served by each airport; and (3) the fact that all traffic to/from Nacala must pass through Nampula airport at present since no other air service is available. A key factor considered was the observed development of new industrial activity in the Nacala area as a result of the institution of the Free Zone and the expansion of economic activity at the port, both of which are intimately related to the availability of air access to the outside world. It was not possible to perform a direct survey of passengers presently using Nampula airport due to the time and budgetary limitations of the present feasibility study.

Taking the above assumed shift of traffic from Nampula to Nacala into account, the de facto annual rate of growth following the transfer at each airport according to the "most likely indicative forecast" differs from that shown in Table 4 above. The adjusted growth rates are 7.3% for the period 2004-2011 and 6.6% for the period 2012-2024 at Nampula and approximately 13.5% for the period 2004-2013 and approximately 10.3% for the period 2014-2024 at Nacala.

3.3.3 ICAO Forecasts

According to the latest long-term forecast of air traffic released by ICAO in April 2007, worldwide scheduled airline passenger traffic will grow at an average annual rate of 4.6% over the 20-year period ending in 2025, in terms of passenger-kilometers flown. This forecast shows international passenger traffic increasing at an average annual rate of 5.3% over this period, versus 3.4% for the domestic sector. Although, airlines in the Middle East and the Asia/Pacific regions are forecast to show the highest growth in passenger traffic during this period, airlines in the African region are expected to show solid growth of 5.1%.

Scheduled air freight traffic on a worldwide basis is forecast to increase at a "most likely" average annual rate of 6.6% during the 20-year period ending in 2025 as measured in terms of ton-kilometers flown. This forecast shows international freight traffic increasing at an average annual rate of 6.9% over this period, versus 4.5% for the domestic sector.

The ICAO forecast also shows worldwide scheduled aircraft movements, in terms of aircraft departures and aircraft kilometers flown, increasing at average annual rates of 3.6% and 4.1%, respectively during this period.

The ICAO forecast states that future air transport growth will continue to be related primarily to world economic and trade growth and airline costs, which, in turn, depend heavily on the evolution of the prices paid for aircraft fuel. Future air transport growth

will also be influenced by potential constraints due to airport and airspace congestion, environmental protection and increasing capital investment needs, as well as by government decisions, notably those determining the type and extent of economic regulation of airlines.

3.3.4 ACI Statistics

According to the 2006 World Airport Traffic Report published by the Airports Council International (ACI) in July 2007, total worldwide passenger traffic reached an all-time high of approximately 4.4 billion passengers, based on final reports received from 1100 member airports of the organization. This represents an overall increase of 4.8% over the previous year. The report also indicates that the strongest growth was in the international sector, with an overall increase of 6.8% and higher rates in the Asia-Pacific and Middle East regions. According to ACI, tourism was the leading factor in the increase in air traffic across the African continent, with countries such as Morocco benefiting from a new open skies agreement with the European Union.

In August 2007, ACI reported that for the first 6 months of 2007, preliminary results indicate that worldwide passenger traffic shows an increase of 5% over the corresponding period for 2006, in line with the organization's traffic outlook. According to ACI's Traffic Forecast Advisory Services "international traffic grew by 6.7% driven mainly by dynamic growth in Africa, the Middle East and Asia Pacific".

3.4 Methodology and Analysis of Determining Factors

A number of different methodologies were considered for the purpose of providing appropriate forecasts of the air traffic to be expected at the airports of Pemba and Nacala. The determination of the most appropriate approach was based on the particular context of the air transport market in Mozambique and especially in the northeastern region of the country. Our approach also took into account the prospects for the coordinated development of tourism and other economic infrastructure in parallel with the proposed improvements at the airports in question.

Our methodology involves the elaboration of a series of alternative scenarios for the growth of air traffic at each of the airports. These scenarios reflect different assumptions regarding the evolution of the local economy. In view of the fact that Nacala has never enjoyed direct commercial air service, we have adopted a methodology based on analogies with similar cases elsewhere in the world.

The Business Prospectus for the Nacala Development Corridor Airports Group provides analogies with the airports of Punta Cana in the Dominican Republic and Cancun in Mexico which served as essential catalysts for the development of major tourism complexes. Both examples indicate a strong relation between the availability of air

service and the development of tourism infrastructure. Beginning in the 1970s as relatively remote and undeveloped fishing villages, both of these resorts can be said to be similar to Nacala in terms of the potential for growth. Thanks to a coordinated development of both airport and tourism infrastructure, Punta Cana now has some 16,000 hotel rooms and the Riviera Maya resort area served by Cancun airport approximately 45,000 rooms. In the case of Nacala, it is impossible to predict the degree to which this scenario will repeat itself, but the previous example does demonstrate the potential for growth which can be achieved by coordinated and professional planning, development and marketing of both tourism and air services.

3.5 Air Traffic Forecasts

The following pages present forecasts of air traffic for each of the airports under consideration, organized according to annual passengers, aircraft movements and cargo (including air mail).

3.5.1 Pemba Airport

Passengers

Taking the traffic recorded at Pemba in 2006 as the base year, we have developed projections of annual passengers at Pemba airport as shown for the **Base Case Scenario** in Table 3.12. The passenger volumes in this table are broken down by traffic sector and correspond to the following annual growth rates:

domestic sector	origin/destination traffic	6.0% (2007-2016) 5.0% (2017-2028)
	transit traffic	3.0%
regional sector	origin/destination traffic	11.0% (2007-2016) 10.0% (2017-2028)
	transit traffic	3.0%
international sector		5000 passengers (2011) 10000 passengers (2012) 15000 passengers (2013) 14.0% (2014-2028)
other	non-commercial traffic	11.0%

The introduction of direct international traffic in 2011 is assumed to coincide with the reduction of a portion of the domestic traffic in that year since passengers at Pemba with international origins/destinations now use domestic flights within Mozambique for part of their journey. The year 2011 corresponds to the assumed delay required for the construction of the runway extension which would be necessary to accommodate long-range international (intercontinental) flights. It is assumed that the international services

would commence with charter flights on a bi-weekly basis and would increase in the same increment for the next two years; following this initial period, international traffic would then increase at an annual growth rate of 14%.

Table 3.12: Pemba Airport Air Traffic Projections (2007-2008) – Base Case

	Annual Passengers								
	domestic			regional			other	int'l	total
	orig/dest	transit	sub-total	orig/dest	transit	sub-total			
2006	56,267	17,626	73,893	6,950	8,095	15,045	1,549	0	90,487
2007	59,643	18,155	77,798	7,715	8,338	16,052	1,595	0	95,446
2008	63,222	18,699	81,921	8,563	8,588	17,151	1,643	0	100,715
2009	67,015	19,260	86,275	9,505	8,846	18,351	1,693	0	106,319
2010	71,036	19,838	90,874	10,551	9,111	19,662	1,743	0	112,279
2011	73,631	20,433	94,065	11,184	9,384	20,568	1,796	5,000	121,428
2012	78,049	21,046	99,096	12,414	9,666	22,080	1,850	10,000	133,025
2013	82,732	21,678	104,410	13,779	9,956	23,735	1,905	15,000	145,050
2014	87,696	22,328	110,024	15,295	10,255	25,550	1,962	17,100	154,636
2015	92,958	22,998	115,956	16,978	10,562	27,540	2,021	19,494	165,010
2016	98,535	23,688	122,223	18,845	10,879	29,724	2,082	22,223	176,252
2017	103,462	24,399	127,861	20,730	11,205	31,935	2,144	25,334	187,274
2018	108,635	25,130	133,766	22,803	11,542	34,344	2,359	28,881	199,349
2019	114,067	25,884	139,951	25,083	11,888	36,971	2,594	32,925	212,441
2020	119,770	26,661	146,431	27,591	12,244	39,835	2,854	37,534	226,655
2021	125,759	27,461	153,219	30,350	12,612	42,962	3,139	42,789	242,109
2022	132,047	28,285	160,331	33,385	12,990	46,375	3,453	48,779	258,939
2023	138,649	29,133	167,782	36,724	13,380	50,103	3,799	55,608	277,292
2024	145,581	30,007	175,589	40,396	13,781	54,177	4,178	63,393	297,338
2025	152,861	30,907	183,768	44,436	14,195	58,630	4,596	72,269	319,263
2026	160,504	31,835	192,338	48,879	14,620	63,500	5,056	82,386	343,280
2027	168,529	32,790	201,318	53,767	15,059	68,826	5,561	93,920	369,626
2028	176,955	33,773	210,728	59,144	15,511	74,655	6,118	107,069	398,570

In addition to the above forecast of passenger traffic at Pemba according to the Base Case scenario, alternative traffic projections were developed to reflect Optimistic and Pessimistic hypotheses regarding the determining factors for the future evolution of the market and the context for air transportation. Tables 3.10 and 3.11 present these projections in the same format as the previous table.

In the case of the **Optimistic Scenario** for Pemba airport, the passenger volumes in the following Table 3.13 are broken down by traffic sector and correspond to the following annual growth rates:

domestic sector	origin/destination traffic	7.0% (2007-2016) 6.0% (2017-2028)
	transit traffic	3.0%
regional sector	origin/destination traffic	13.0% (2007-2016) 12.0% (2017-2028)
	transit traffic	3.0%
international sector		5000 passengers (2011) 10000 passengers (2012)

		15000 passengers (2013) 20000 passengers (2014) 15.0% (2011-2028)
other	non-commercial traffic	11.0%

Under the Optimistic Scenario for Pemba it is assumed that the international services would commence with charter flights on a bi-weekly basis and would increase in the same increment for the next three years; following this initial period, international traffic would then increase at an annual growth rate of 15%.

Table 3.13: Pemba Airport Air Traffic Projections (2007-2028) - Optimistic Scenario

	Annual Passengers								
		domestic			regional		other	int'l	total
	orig/dest	transit	sub-total	orig/dest	transit	sub-total			
2006	56 267	17 626	73 893	6 950	8 095	15 045	1 549	0	90 487
2007	60 206	18 155	78 360	7 854	8 338	16 191	1 595	0	96 147
2008	64 420	18 699	83 120	8 874	8 588	17 462	1 643	0	102 225
2009	68 929	19 260	88 190	10 028	8 846	18 874	1 693	0	108 756
2010	73 755	19 838	93 593	11 332	9 111	20 443	1 743	0	115 779
2011	78 917	20 433	99 351	12 805	9 384	22 189	1 796	5 000	128 336
2012	84 442	21 046	105 488	14 470	9 666	24 135	1 850	10 000	141 473
2013	90 353	21 678	112 030	16 351	9 956	26 306	1 905	15 000	155 242
2014	96 677	22 328	119 005	18 476	10 255	28 731	1 962	20 000	169 698
2015	103 445	22 998	126 443	20 878	10 562	31 440	2 021	23 000	182 904
2016	110 686	23 688	134 374	23 592	10 879	34 471	2 082	26 450	197 377
2017	117 327	24 399	141 725	26 423	11 205	37 629	2 144	30 418	211 916
2018	124 366	25 130	149 497	29 594	11 542	41 136	2 359	34 980	227 971
2019	131 828	25 884	157 713	33 145	11 888	45 033	2 594	40 227	245 568
2020	139 738	26 661	166 399	37 123	12 244	49 367	2 854	46 261	264 881
2021	148 122	27 461	175 583	41 578	12 612	54 189	3 139	53 200	286 112
2022	157 010	28 285	185 294	46 567	12 990	59 557	3 453	61 180	309 485
2023	166 430	29 133	195 563	52 155	13 380	65 535	3 799	70 358	335 254
2024	176 416	30 007	206 423	58 414	13 781	72 195	4 178	80 911	363 708
2025	187 001	30 907	217 908	65 423	14 195	79 618	4 596	93 048	395 170
2026	198 221	31 835	230 056	73 274	14 620	87 894	5 056	107 005	430 011
2027	210 115	32 790	242 904	82 067	15 059	97 126	5 561	123 056	468 647
2028	222 721	33 773	256 495	91 915	15 511	107 426	6 118	141 514	511 552

In the case of the **Pessimistic Scenario** for Pemba airport, the passenger volumes in the following Table 3.14 are broken down by traffic sector and correspond to the following annual growth rates:

domestic sector	origin/destination traffic	5.0% (2007-2016) 4.0% (2017-2028)
	transit traffic	3.0%
regional sector	origin/destination traffic	10.0% (2007-2016) 9.0% (2017-2028)
	transit traffic	3.0%

international sector		5000 passengers (2011) 10000 passengers (2012) 15000 passengers (2013) 12.0% (2011-2028)
other	non-commercial traffic	11.0%

Table 3.14: Pemba Airport Air Traffic Projections (2007-2028) - Pessimistic Scenario

	Annual Passengers								
		domestic			regional		other	int'l	total
	orig/dest	transit	sub-total	orig/dest	transit	sub-total			
2006	56,267	17,626	73,893	6,950	8,095	15,045	1,549	0	90,487
2007	59,080	18,155	77,235	7,645	8,338	15,983	1,595	0	94,813
2008	62,034	18,699	80,734	8,410	8,588	16,997	1,643	0	99,375
2009	65,136	19,260	84,396	9,250	8,846	18,096	1,693	0	104,185
2010	68,393	19,838	88,231	10,175	9,111	19,286	1,743	0	109,261
2011	71,813	20,433	92,246	11,193	9,384	20,577	1,796	5,000	119,619
2012	75,403	21,046	96,450	12,312	9,666	21,978	1,850	10,000	130,277
2013	79,173	21,678	100,851	13,544	9,956	23,499	1,905	15,000	141,256
2014	83,132	22,328	105,460	14,898	10,255	25,152	1,962	16,800	149,375
2015	87,289	22,998	110,287	16,388	10,562	26,950	2,021	18,816	158,073
2016	91,653	23,688	115,341	18,027	10,879	28,906	2,082	21,074	167,402
2017	95,319	24,399	119,718	19,649	11,205	30,854	2,144	23,603	176,319
2018	99,132	25,130	124,262	21,417	11,542	32,959	2,359	26,435	186,015
2019	103,097	25,884	128,982	23,345	11,888	35,233	2,594	29,607	196,416
2020	107,221	26,661	133,882	25,446	12,244	37,690	2,854	33,160	207,586
2021	111,510	27,461	138,971	27,736	12,612	40,348	3,139	37,139	219,597
2022	115,970	28,285	144,255	30,232	12,990	43,222	3,453	41,596	232,527
2023	120,609	29,133	149,742	32,953	13,380	46,333	3,799	46,588	246,461
2024	125,433	30,007	155,441	35,919	13,781	49,700	4,178	52,178	261,497
2025	130,451	30,907	161,358	39,152	14,195	53,346	4,596	58,440	277,740
2026	135,669	31,835	167,503	42,675	14,620	57,296	5,056	65,452	295,307
2027	141,096	32,790	173,885	46,516	15,059	61,575	5,561	73,307	314,328
2028	146,739	33,773	180,513	50,703	15,511	66,213	6,118	82,103	334,947

Aircraft Movements

Forecasts of aircraft movements at Pemba were prepared along the same lines as the passenger projections. Using the aircraft operations recorded at Pemba in 2006 as the base year, we have developed forecasts of annual aircraft movements (landings + take-offs) at Pemba airport for the period from 2007 to 2028, as shown for the **Base Case Scenario** in Table 3.15. The aircraft movements in this table are broken down by traffic sector and correspond to the following annual growth rates:

domestic sector	4.0% (2007-2016) 3.0% (2017-1028)
regional sector	8.0% (2007-2016) 7.0% (2017-1028)

international sector	100 flights (2011) 200 flights (2012) 300 flights (2013) 12.0% (2014-2028)
other (general aviation)	11.0% (2007-2028)

It is assumed that the international services would commence with charter flights on a bi-weekly basis and would increase in the same increment for the next two years; following this initial period, international aircraft movements would then increase at an annual growth rate of 12%. In the case of general aviation flights, we used the average of the annual number of flights over the past eleven years as a starting point rather than the value for the year 2006, since the latter appeared to be anomalous and the traffic in this sector over that period did not show any discernable pattern.

In addition to the above forecast of aircraft movements at Pemba according to the Base Case scenario, alternative traffic projections were developed to reflect Optimistic and Pessimistic hypotheses regarding the determining factors for the future evolution of the market and the context for air transportation. Tables 3.16 and 3.17 present these projections in the same format as the previous table.

Table 3.15: Pemba Airport Air Traffic Projections (2007 – 2028) – Base Case

	Annual Aircraft Movements				
	domestic	**regional**	**other**	**int'l**	**total**
2006	5,413	766	163	0	6,342
2007	5,630	827	181	0	5,810
2008	5,855	893	201	0	6,056
2009	6,089	965	223	0	6,312
2010	6,332	1,042	247	0	6,580
2011	6,586	1,126	275	100	6,960
2012	6,849	1,216	305	200	7,354
2013	7,123	1,313	338	300	7,762
2014	7,408	1,418	376	336	8,120
2015	7,704	1,531	417	376	8,498
2016	8,013	1,654	463	421	8,897
2017	8,253	1,769	514	472	9,239
2018	8,501	1,893	570	529	9,599
2019	8,756	2,026	633	592	9,981
2020	9,018	2,168	703	663	10,384
2021	9,289	2,319	780	743	10,811
2022	9,567	2,482	866	832	11,265
2023	9,854	2,656	961	932	11,747
2024	10,150	2,841	1,067	1,044	12,260
2025	10,455	3,040	1,184	1,169	12,807
2026	10,768	3,253	1,314	1,309	13,391
2027	11,091	3,481	1,459	1,466	14,016
2028	11,424	3,725	1,619	1,642	14,685

In the case of the **Optimistic Scenario** for Pemba airport, the aircraft movements in Table 3.16 are broken down by traffic sector and correspond to the following annual growth rates:

domestic sector	5.0% (2007-2016) 4.0% (2017-1028)
regional sector	10.0% (2007-2016) 9.0% (2017-1028)
international sector	100 flights (2011) 200 flights (2012) 300 flights (2013) 400 flights (2014) 13.0% (2015-2028)
other (general aviation)	12.0% (2007-2028)

Under the Optimistic Scenario for Pemba it is assumed that the international services would commence with charter flights on a bi-weekly basis and would increase in the same increment for the next three years; following this initial period, international aircraft movements would then increase at an annual growth rate of 13%. In the case of general aviation flights, we used the average of the annual number of flights over the past eleven years as a starting point rather than the value for the year 2006, since the latter appeared to be anomalous and the traffic in this sector over that period did not show any discernable pattern.

Table 3.16: Pemba Airport Air Traffic Projections (2007-2028) - Optimistic Scenario

	Annual Aircraft Movements				
	domestic	regional	other	int'l	total
2006	5,413	766	163	0	6,342
2007	5,684	843	183	0	5,866
2008	5,968	927	204	0	6,172
2009	6,266	1,020	229	0	6,495
2010	6,580	1,122	256	0	6,836
2011	6,909	1,234	287	100	7,296
2012	7,254	1,357	322	200	7,776
2013	7,617	1,493	360	300	8,277
2014	7,997	1,642	404	400	8,801
2015	8,397	1,806	452	452	9,301
2016	8,817	1,987	506	511	9,834
2017	9,170	2,166	567	577	10,314
2018	9,537	2,361	635	652	10,824
2019	9,918	2,573	711	737	11,366
2020	10,315	2,805	797	833	11,944
2021	10,727	3,057	892	941	12,561
2022	11,157	3,332	999	1,063	13,219
2023	11,603	3,632	1,119	1,202	13,924
2024	12,067	3,959	1,253	1,358	14,678
2025	12,550	4,315	1,404	1,534	15,488
2026	13,052	4,703	1,572	1,734	16,358
2027	13,574	5,127	1,761	1,959	17,294
2028	14,117	5,588	1,972	2,214	18,303

In the case of the **Pessimistic Scenario** for Pemba airport, the aircraft movements in **Table 3.17** are broken down by traffic sector and correspond to the following annual growth rates:

domestic sector	3.0% (2007-2016) 2.0% (2017-1028)

regional sector	7.0% (2007-2016) 6.0% (2017-1028)
international sector	100 flights (2011) 200 flights (2012) 300 flights (2013) 10.0% (2015-2028)
other (general aviation)	9.0% (2007-2028)

Under the Pessimistic Scenario for Pemba it is assumed that the international services would commence with charter flights on a bi-weekly basis and would increase in the same increment for the next two years; following this initial period, international aircraft movements would then increase at an annual growth rate of 10%. In the case of general aviation flights, we used the average of the annual number of flights over the past eleven years as a starting point rather than the value for the year 2006, since the latter appeared to be anomalous and the traffic in this sector over that period did not show any discernable pattern.

3.5.2 Nacala Airport Passengers

For the proposed new civilian airport facilities at Nacala, we have developed projections of air traffic indicators based on an assumed initial shift of portions of domestic commercial traffic from Nampula in 2010-2011 together with the initiation of regional air traffic at the same time. Other (non-commercial traffic) is assumed to commence in 2008, following the transfer of management of the facilities to ADM and opening of the airport to civilian general aviation.

Passenger traffic is assumed to commence in 2010, following construction of a terminal building and revision of the aircraft parking apron to accommodate commercial flights. The passenger volumes in Table 3.18 are broken down by traffic sector and correspond to the following annual growth rates:

domestic sector	origin/destination traffic	8.0% (2010-2018) 7.0% (2019-2028)
	transit traffic	3.0%
regional sector	origin/destination traffic	11.0% (2010-2018) 10.0% (2019-2028)
	transit traffic	3.0%
international sector		5000 passengers (2011) 10000 passengers (2012) 15000 passengers (2013) 14.0% (2014-2028)
other	non-commercial traffic	11.0%

Table 3.18: Nacala Airport Air Traffic Projections (2007-2028) – Base Case

	Annual Passengers								
	domestic			regional			other	int'l	total
	orig/dest	transit	sub-total	orig/dest	transit	sub-total			
2006	0	0	0	0	0	0	0	0	0
2007	0	0	0	0	0	0	0	0	0
2008	0	0	0	0	0	0	1 500	0	1 500
2009	0	0	0	0	0	0	1 560	0	1 560
2010	34 949	10 485	45 434	10 000	9 000	19 000	1 607	0	66 041
2011	74 767	10 799	85 566	10 600	9 270	19 870	1 655	5 000	112 091
2012	80 748	11 123	91 871	11 766	9 548	21 314	1 705	10 000	124 890
2013	87 208	11 457	98 665	13 060	9 835	22 895	1 756	15 000	138 315
2014	94 184	11 801	105 985	14 497	10 130	24 626	1 808	17 100	149 520
2015	101 719	12 155	113 874	16 092	10 433	26 525	1 863	19 494	161 756
2016	109 857	12 519	122 376	17 862	10 746	28 608	1 919	22 223	175 126
2017	118 645	12 895	131 540	19 826	11 069	30 895	1 976	25 334	189 746
2018	128 137	13 282	141 419	22 007	11 401	33 408	2 174	28 881	205 882
2019	137 106	13 680	150 787	24 208	11 743	35 951	2 391	32 925	222 053
2020	146 704	14 091	160 794	26 629	12 095	38 724	2 630	37 534	239 683
2021	156 973	14 513	171 486	29 292	12 458	41 750	2 893	42 789	258 918
2022	167 961	14 949	182 910	32 221	12 832	45 053	3 183	48 779	279 925
2023	179 719	15 397	195 116	35 443	13 217	48 660	3 501	55 608	302 885
2024	192 299	15 859	208 158	38 987	13 613	52 601	3 851	63 393	328 003
2025	205 760	16 335	222 095	42 886	14 022	56 908	4 236	72 269	355 507
2026	220 163	16 825	236 988	47 175	14 442	61 617	4 660	82 386	385 651
2027	235 574	17 330	252 904	51 892	14 876	66 768	5 126	93 920	418 718
2028	252 065	17 850	269 914	57 081	15 322	72 403	5 638	107 069	455 025

In addition to the above forecast of passenger traffic at Nacala according to the Base Case scenario, alternative traffic projections were developed to reflect Optimistic and Pessimistic hypotheses regarding the determining factors for the future evolution of the market and the context for air transportation. Tables 3.19 and 3.20 present these projections in the same format as the previous table.

In the case of the **Optimistic Scenario** for Nacala airport, the passenger volumes in Table 13.19 are broken down by traffic sector and correspond to the following annual growth rates:

domestic sector	origin/destination traffic	10.0% (2007-2018) 9.0% (2019-2028)
	transit traffic	3.0%
regional sector	origin/destination traffic	13.0% (2007-2018) 12.0% (2019-2028)
	transit traffic	3.0%
international sector		15.0% (2011-2028)
other	non-commercial traffic	11.0%

Table 3.19: Nacala Airport Air Traffic Projections (2007-2028) – Optimistic Case

	Annual Passengers								
	domestic			regional			other	int'l	total
	orig/dest	transit	sub-total	orig/dest	transit	sub-total			
2006	0	0	0	0	0	0	0	0	0
2007	0	0	0	0	0	0	0	0	0
2008	0	0	0	0	0	0	1 500	0	1 500
2009	0	0	0	0	0	0	1 560	0	1 560
2010	34 949	10 485	45 434	10 000	9 000	19 000	1 607	0	66 041
2011	75 466	10 799	86 265	11 300	9 270	20 570	1 655	5 000	113 490
2012	83 012	11 123	94 135	12 769	9 548	22 317	1 705	10 000	128 157
2013	91 313	11 457	102 770	14 429	9 835	24 264	1 756	15 000	143 790
2014	100 445	11 801	112 245	16 305	10 130	26 434	1 808	20 000	160 488
2015	110 489	12 155	122 644	18 424	10 433	28 858	1 863	23 000	176 364
2016	121 538	12 519	134 057	20 820	10 746	31 566	1 919	26 450	193 992
2017	133 692	12 895	146 587	23 526	11 069	34 595	1 976	30 418	213 575
2018	147 061	13 282	160 343	26 584	11 401	37 985	2 174	34 980	235 482
2019	160 297	13 680	173 977	29 775	11 743	41 518	2 391	40 227	258 113
2020	174 723	14 091	188 814	33 348	12 095	45 443	2 630	46 261	283 148
2021	190 448	14 513	204 962	37 349	12 458	49 807	2 893	53 200	310 863
2022	207 589	14 949	222 537	41 831	12 832	54 663	3 183	61 180	341 564
2023	226 272	15 397	241 669	46 851	13 217	60 068	3 501	70 358	375 595
2024	246 636	15 859	262 495	52 473	13 613	66 086	3 851	80 911	413 344
2025	268 833	16 335	285 168	58 770	14 022	72 791	4 236	93 048	455 244
2026	293 028	16 825	309 853	65 822	14 442	80 264	4 660	107 005	501 782
2027	319 401	17 330	336 731	73 721	14 876	88 596	5 126	123 056	553 508
2028	348 147	17 850	365 997	82 567	15 322	97 889	5 638	141 514	611 038

In the case of the Pessimistic scenario for Nacala airport, the passenger volumes in the Table 3.20 are broken down by traffic sector and correspond to the following annual growth rates:

domestic sector	origin/destination traffic	6.0% (2007-2016) 5.0% (2017-2028)
	transit traffic	3.0%
regional sector	origin/destination traffic	10.0% (2007-2016) 9.0% (2017-2028)
	transit traffic	3.0%
international sector		12.0% (2011-2028)
other	non-commercial traffic	11.0%

Table 3.20: Nacala Airport Air Traffic Projections (2007-2028) - Pessimistic

	Annual Passengers								
	domestic			regional			other	int'l	total
	orig/dest	transit	sub-total	orig/dest	transit	sub-total			
2006	0	0	0	0	0	0	0	0	0
2007	0	0	0	0	0	0	0	0	0
2008	0	0	0	0	0	0	1 500	0	1 500
2009	0	0	0	0	0	0	1 560	0	1 560
2010	34 949	10 485	45 434	10 000	9 000	19 000	1 607	0	66 041
2011	74 068	10 799	84 867	11 000	9 270	20 270	1 655	5 000	111 792
2012	78 512	11 123	89 635	12 100	9 548	21 648	1 705	10 000	122 988
2013	83 222	11 457	94 679	13 310	9 835	23 145	1 756	15 000	134 580
2014	88 216	11 801	100 016	14 641	10 130	24 771	1 808	16 800	143 395
2015	93 509	12 155	105 663	16 105	10 433	26 539	1 863	18 816	152 881
2016	99 119	12 519	111 639	17 716	10 746	28 462	1 919	21 074	163 093
2017	105 066	12 895	117 961	19 487	11 069	30 556	1 976	23 603	174 096
2018	111 370	13 282	124 652	21 436	11 401	32 837	2 174	26 435	186 098
2019	116 939	13 680	130 619	23 365	11 743	35 108	2 391	29 607	197 726
2020	122 786	14 091	136 876	25 468	12 095	37 563	2 630	33 160	210 230
2021	128 925	14 513	143 438	27 760	12 458	40 218	2 893	37 139	223 689
2022	135 371	14 949	150 320	30 259	12 832	43 090	3 183	41 596	238 189
2023	142 140	15 397	157 537	32 982	13 217	46 199	3 501	46 588	253 824
2024	149 247	15 859	165 106	35 950	13 613	49 563	3 851	52 178	270 699
2025	156 709	16 335	173 044	39 186	14 022	53 207	4 236	58 440	288 927
2026	164 545	16 825	181 370	42 712	14 442	57 155	4 660	65 452	308 636
2027	172 772	17 330	190 102	46 556	14 876	61 432	5 126	73 307	329 966
2028	181 411	17 850	199 260	50 747	15 322	66 068	5 638	82 103	353 070

Aircraft Movements

For the proposed new civilian airport facilities at Nacala, we have developed projections of aircraft movements based on an assumed initial shift of portions of domestic commercial traffic from Nampula in 2010-2011 together with the initiation of regional air traffic at the same time. Other (non-commercial traffic) is assumed to commence immediately in 2008, following the proposed transfer of management of the facilities to ADM and opening of the airport to civilian general aviation. Passenger flights are assumed to commence in 2010, following construction of a terminal building and revision of the aircraft parking apron to accommodate commercial flights. The aircraft movements in Table 3.21 are broken down by traffic sector and correspond to the following annual growth rates:

domestic sector	6.0% (2010-2018) 5.0% (2019-1028)
regional sector	9.0% (2010-2018) 8.0% (2019-1028)
international sector	100 flights (2011) 200 flights (2012) 300 flights (2013) 12.0% (2014-2028)
other (general aviation)	11.0% (2007-2028)

Table 3.21: Nacala Airport Air Traffic Projections (2007-2028) – Base Case

	Annual Aircraft Movements				
	domestic	regional	other	int'l	total
2006	0	0	0	0	0
2007	0	0	0	0	0
2008	0	0	163	0	163
2009	0	0	181	0	181
2010	1,100	462	201	0	1,762
2011	2,331	979	223	100	3,633
2012	2,471	1,067	247	200	3,985
2013	2,619	1,163	275	300	4,356
2014	2,776	1,268	305	336	4,685
2015	2,942	1,382	338	376	5,039
2016	3,119	1,506	376	421	5,422
2017	3,306	1,642	417	472	5,837
2018	3,505	1,789	463	529	6,286
2019	3,680	1,933	514	592	6,718
2020	3,864	2,087	570	663	7,184
2021	4,057	2,254	633	743	7,687
2022	4,260	2,435	703	832	8,229
2023	4,473	2,629	780	932	8,814
2024	4,696	2,840	866	1,044	9,445
2025	4,931	3,067	961	1,169	10,128
2026	5,178	3,312	1,067	1,309	10,866
2027	5,437	3,577	1,184	1,466	11,664
2028	5,709	3,863	1,314	1,642	12,528

It is assumed that the international services would commence with charter flights on a bi-weekly basis and would increase in the same increment for the next two years; following this initial period, international aircraft movements would then increase at an annual growth rate of 12%. In the case of general aviation flights, we used the average of the annual number of flights at Pemba over the past eleven years as a starting point rather than the value for the year 2006, since the latter appeared to be anomalous and the traffic in this sector over that period did not show any discernable pattern.

In addition to the above forecast of aircraft movements at Nacala according to the Base Case scenario, alternative traffic projections were developed to reflect Optimistic and Pessimistic hypotheses regarding the determining factors for the future evolution of the market and the context for air transportation. Tables 3.22 and 3.23 present these projections in the same format as the previous table.

In the case of the **Optimistic Scenario** for Nacala airport, the aircraft movements in Table 3.22 are broken down by traffic sector and correspond to the following annual growth rates:

domestic sector	9.0% (2010-2018) 8.0% (2019-1028)
regional sector	11.0% (2010-2018) 10.0% (2019-1028)
international sector	100 flights (2011) 200 flights (2012) 300 flights (2013) 400 flights (2014) 13.0% (2015-2028)
other (general aviation)	12.0% (2008-2028)

Under the Optimistic Scenario for Nacala it is assumed that the international services would commence with charter flights on a bi-weekly basis and would increase in the same increment for the next three years; following this initial period, international aircraft movements would then increase at an annual growth rate of 13%. In the case of general aviation flights, we used the average of the annual number of flights over the past eleven years at Pemba as a starting point rather than the value for the year 2006, since the latter appeared to be anomalous and the traffic in this sector over that period did not show any discernable pattern.

Table 3.22: Nacala Airport Air Traffic Projections (2007-2028) – Optimistic Scenario

	Annual Aircraft Movements				
	domestic	regional	other	int'l	total
2006	0	0	0	0	0
2007	0	0	0	0	0
2008	0	0	163	0	163
2009	0	0	183	0	183
2010	1,100	462	204	0	1,766
2011	2,364	993	229	100	3,685
2012	2,576	1,102	256	200	4,135
2013	2,808	1,223	287	300	4,619
2014	3,061	1,358	322	400	5,141
2015	3,337	1,507	360	452	5,656
2016	3,637	1,673	404	511	6,224
2017	3,964	1,857	452	577	6,850
2018	4,321	2,061	506	652	7,541
2019	4,667	2,267	567	737	8,238
2020	5,040	2,494	635	833	9,002
2021	5,443	2,743	711	941	9,839
2022	5,879	3,018	797	1,063	10,756
2023	6,349	3,319	892	1,202	11,762
2024	6,857	3,651	999	1,356	12,865
2025	7,405	4,017	1,119	1,534	14,075
2026	7,998	4,416	1,253	1,734	15,403
2027	8,638	4,860	1,404	1,959	16,861
2028	9,329	5,346	1,572	2,214	18,461

In the case of the **Pessimistic Scenario** for Nacala airport, the aircraft movements in Table 3.23 are broken down by traffic sector and correspond to the following annual growth rates:

domestic sector	4.0% (2010-2018) 3.0% (2019-1028)
regional sector	8.0% (2010-2018) 7.0% (2017-1028)
international sector	100 flights (2011) 200 flights (2012) 300 flights (2013) 10.0% (2014-2028)
other (general aviation)	9.0% (2007-2028)

Under the Pessimistic Scenario for Nacala it is assumed that the international services would commence with charter flights on a bi-weekly basis and would increase in the same increment for the next two years; following this initial period, international aircraft movements would then increase at an annual growth rate of 10%. In the case of general aviation flights, we used the average of the annual number of flights over the past eleven years at Pemba as a starting point rather than the value for the year 2006, since the latter appeared to be anomalous and the traffic in this sector over that period did not show any discernable pattern.

Table 3.23: Nacala Airport Air Traffic Projections (2007-2028) – Pessimistic Scenario

	Annual Aircraft Movements				
	domestic	regional	other	int'l	total
2006	0	0	0	0	0
2007	0	0	0	0	0
2008	0	0	163	0	163
2009	0	0	178	0	178
2010	1,100	462	194	0	1,755
2011	2,309	970	211	100	3,589
2012	2,401	1,047	230	200	3,878
2013	2,497	1,131	251	300	4,179
2014	2,597	1,221	273	330	4,422
2015	2,701	1,319	298	363	4,681
2016	2,809	1,425	325	399	4,958
2017	2,921	1,539	354	439	5,253
2018	3,038	1,662	386	483	5,569
2019	3,129	1,778	421	531	5,860
2020	3,223	1,903	458	585	6,169
2021	3,320	2,036	500	643	6,498
2022	3,419	2,178	545	707	6,850
2023	3,522	2,331	594	778	7,225
2024	3,628	2,494	647	856	7,625
2025	3,737	2,669	705	942	8,052
2026	3,849	2,855	769	1,036	6,509
2027	3,964	3,055	838	1,139	8,997
2028	4,083	3,269	914	1,253	9,519

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SECTION 4: COMPARATIVE FINANCIAL ANALYSIS

4.1 Analysis of Airports Financial Data

As specified in the Terms of Reference, AAROTEC performed a preliminary comparative financial analysis of airport facility development programs aimed at accommodating long-range international air traffic for both options: Pemba and Nacala. The required investments at each site were evaluated in terms of standard indicators of financial performance. The financial analyses were based on the forecasts of traffic at each airport and preliminary capital investment requirements as presented in the Inception Report.

4.1.1 Airport Charges

The airport charges are set by the Council of Ministers, the most recent schedule being established by virtue of Decree Number 36/97 dated October 21, 1997. In this decree, a distinction is made between the charges applicable to different categories of airports and aerodromes, which are defined as follows:

Airport Category	Definition
Airports	having infrastructures and equipment dimensioned for the movement of **long-range jet aircraft** and permanent facilities for the deplaning of international traffic
Principal Aerodromes	having infrastructures and equipment dimensioned for the movement of **medium-range jet aircraft** and intended for domestic traffic
Secondary Aerodromes	having infrastructures and equipment dimensioned for **other types of aircraft**.

At present, Pemba airport is classified as a "Principal Aerodrome" for the purpose of establishing the schedule of applicable airport charges, even though the airport handles international flights within the Southern Africa region, notably to/from Johannesburg, Nairobi and Dar es Salam. If the proposed improvements were implemented (especially the extension of the runway), then the airport would properly fall under the "Airport" classification, since the new runway length would be dimensioned specifically to be able to handle long-range international traffic. At that point, the schedule of airport charges at Pemba would be those applicable to the "Airport" category.

In the case of the creation of a new civilian airport at Nacala, the situation is more complicated. Although the existing runway (2500 m) is clearly sufficient to accommodate long-range international traffic, the airport will probably serve the domestic market at first. We have assumed that ADM will adopt a strategy of phased operation of Nacala as a civilian airport, as follows: Phase 1 (2008-2009) – transfer of

the airport installations to control by ADM and implementation of basic improvements intended to handle non-controlled general aviation traffic under visual flight rules (VFR); Phase 2 (2010-1011) – implementation of improvements intended to handle controlled air traffic in the domestic sector; and Phase 3 (beyond 2012) – implementation of measures to ensure full compliance with ICAO Standards and Recommended Practices (SARPs) and capability to handle long-range international traffic.

Taking the above considerations into account, we have established the following timetable for the categorization of the two airports:

Airport	Time Frame	Category
Pemba	2007-2010 2011+	Principal Aerodrome Airport
Nacala	2008-2009 2010-2011 2012+	Secondary Aerodrome Principal Aerodrome Airport

4.1.2 Preliminary Capital Investment Requirements

Preliminary estimates of the required capital investments at each airport have been developed based on a demand/capacity analysis and determinations of facility requirements as presented in the Inception Report prepared as part of the present study. These cost estimates include engineering costs and capital costs for each of the proposed airport development scenarios, and are based on international and local unit costs.

These estimates are to be considered as a conceptual estimate for the purposes of the present comparative financial feasibility analysis only. More detailed determinations of the financial feasibility of the selected option appear in Section 11 of the present Final Report.

Capital Investment Program

The capital Investment projects include the following:

1. Airside Works
2. Landside Works
3. Navaids and Specialty Equipment
4. Other Projects

The following Tables 4.1 and Table 4.2 show summaries of the capital investment program for both airports.

Cost Estimating Methodologies

For the purposes of the present preliminary comparative financial analysis, the cost

estimates used should be considered as indicative of an order of magnitude. Unit costs were extracted from similar projects recently reviewed by the Consultant in terms of scope, productivity rates, material, equipment cost and were priced using locally obtained labor rates. In instances where specialized or imported materials will be required, historical or quoted prices were used and a freight allowance was applied.

All engineering, procurement and construction costs include the following:

1. Contractors Overhead and Profit
2. Insurance and Bonds
3. Value Added Tax
4. Conceptual Level Contingency
5. Design Fee

The above-mentioned summaries of capital costs do not include the following:

1. Any applicable special taxes
2. Local professional association fees
3. Inflation escalation factors

No geo-technical engineering information was available during the preparation of the estimate. This estimate assumes that the existing subsurface conditions will allow for conventional shallow foundations and conventional pavement construction without the need of any specialized ground modification technique.

Table 4.1 Summary of Preliminary Capital Investment Program

	Investment Program (USD x 1000)						
	2009	2010	2013	2018	2023	2028	Total
Nacala							
Airside Works	2,665	1,776	1,776	1,332	1,332		8,882
Passenger Terminal	6,000		5,000		5,000	5,000	21,000
Landside Works	1,672	1,229	1,672	1,115			5,687
Navaida + Eqpt.	1,635	3,796	2,160	1,636	1,636		10,863
Cargo Terminal	61	81	53				1945
Repaving				2,044		2,044	4,088
Total Nacala	**12,032**	**6,882**	**10,661**	**6,126**	**7,968**	**7,044**	**50,714**
Pemba							
Airside Works	7,500	5,000	6,500				22,500
Passenger Terminal	12,000	3,500	8,000		1,850		25,350
Landside Works	1,221	1,294	1,221				3,736
Cargo Terminal		4,000				4,000	8,000
Navaids + Eqpt.	146	194	146				486
Repaving				1,149		1,149	2,298
Total Pemba	**20,866**	**13,989**	**15,866**	**1,149**	**1,850**	**5,149**	**58,869**

Table 4.2 Cost Comparison of Alternative Scenarios

	Investment Requirements (USD x 1000)						
	2009	2010	2013	2018	2023	2028	Total
Pemba Regional and Nacala International							
Pemba Regional	5,000	8,500	1,323	8,500	12,000	2,200	37,523
Nacala International	12,032	6,882	10,661	6,126	7,966	7,044	50,714
Totals							**88,237**
Pemba International and Nacala Regional							
Pemba International	20,866	13,989	15,866	1,149	1,850	5,149	58,869
Nacala Regional	5,000	8,500	3,500	2,500	3,000	2,200	24,700
Totals							**83,569**
Pemba and Nacala International							
Pemba International	20,866	13,989	15,866	1,149	1,850	5,149	58,869
Nacala International	12,032	6,882	10,661	6,126	7,968	7,044	50,714
Totals							**109,583**

4.2 Overall Financial Approach

The purpose of this Section is to present financial analyses for Pemba and Nacala Airports that will assist ADM to determine which of these airports it should select for

upgrade to International Status. The financial analysis is based on conventional techniques utilized in the airport industry, which are depicted in the yellow portions of Exhibit 4-1: Financial Analysis Approach:

- **Develop Financing Plan** – In this step, the portions of the capital development costs for each airport to be funded with airport contribution and external borrowing will be developed. Also, the terms of the external borrowing arrangements for each airport will be formulated and the debt service requirements for these segments will be calculated. As shown in green in Exhibit 4-1, the principal determinants of the financing plan will be the facility requirements, which are presented in a elsewhere in this Report.

- **Develop Operating Revenue Projections** – This step will develop the operating revenue projections for each airport. As shown in Exhibit 4-1 in green, the aviation traffic forecasts and the facility development requirements developed elsewhere in the Report are the principal drivers of the revenue projections.

- **Develop Operating Expense Projections** – In this step, the operating expenses for each airport will be developed. Likewise, as shown in green in Exhibit 4-1, the principle drivers for the operating expense projections are the aviation traffic forecasts and facility development requirements developed in earlier sections of this Report.

- **Develop Cash Flow Projections** – This step will develop the cash flow projections for each airport. As shown in Exhibit 4-1, this step consists of combining elements developed in the preceding sections, adding the Operating Revenue projections and subtracting the Operating Expense projections, the airport contributions, the interest requirements and the principal requirements, resulting in the net cash flow for these airports.

- **Develop Net Present Value (NPV) and Internal Rate of Return (IRR) Calculations** – Finally, in this step, measures of the financial performance for each of the airports will be developed. The NPV represents the present value of the future cash flows, determined by discounting such cash flows by the Weighted Average Cost of Capital (WACC); if the NPV is positive, then the investment in the development program would be justified. The IRR represents the discount rate that would equate the present value of the inflows with the present value of the outflows; if the IRR is higher than the WACC, then the investment in the development program would be justified. The target IRR required by ADM is 18%.

4.3 Financial Projections

4.3.1 Pemba Airport

This section presents the financial analysis for Pemba Airport and includes subsections regarding the financing plan, operating revenue projections, operating expense projections, cash flow projections and NPV and IRR calculations.

Pemba Airport Financing Plan

Table 4.3 presents Pemba Airport's financing plan. This table consists of three components. First, the capital cost requirements which were developed elsewhere in the Inception Report are summarized, amounting to a total of US$18,198,000 staged over the 2009 through 2028 period. Second, the funding sources for these costs are developed, consisting of US$5,459,000 of airport contributions (30%) and US$12,738,000 of external borrowings (70%) also spread over 2009 through 2028; the external borrowings reflect a series of term loans, each with 8.5% interest rates and 15 year repayment terms, consistent with lending parameters of the African Development Bank. Third, the debt service requirements are determined, including US$8,563,000 of interest and US$10,365,000 of principal occurring over the 2009 through 2028 period; the outstanding principal balance would be US$2,374,000 as of 2028. These airport contributions, interest requirements and principal requirements are used in the cash flow projections, as well as the NPV and IRR calculations, presented later in this section of the Final Report.

Pemba Airport Operating Revenue Projections

Pemba Airport's operating revenues in 2006 were provided by ADM and are projected to increase from US$630,000 in 2006 to US$13,323,000 in 2028, representing an average annual growth rate of 14.9%. On a per enplaned passenger basis, operating revenues increase from US$13.92 in 2006 to US$66.85 in 2028, or an average annual growth rate of 7.39%.

In general, each of these Operating Revenue projections reflect inflation, which is applied at five-year intervals at the compounded rate of 17.34%, corresponding to 50% of the recent annual inflation rate of 6.50%, over the 2006 through 2028 projection period; inflation is not necessarily mentioned again below. Also, these revenue projections reflect growth in aviation traffic and aeronautical facilities, whichever is relevant. Pemba Airport has nine revenue elements, and the assumptions used to develop projections for each element are reviewed below:

- **Landing Fees)** – These charges are payable in US dollars and based on the maximum take-off weight (MTOW) of aircraft arrivals, with different rates applicable to three categories of airports. These projections reflect rate increases that would occur when Pemba Airport moves from the Principal Aerodromes category in 2010 to the Airports category in 2011, as explained previously in this Section of the Inception Report. Also, these projections reflect the level of aircraft operations each year, since the traffic forecasts do not include calculation of MTOW. Landing

Fee charges are projected to increase from US$202,000 in 2006 to US$887,000 in 2028, corresponding to a 6.96% average annual growth rate.

- **Parking Charges)** – These charges, likewise, are payable in US dollars and based on MTOW for aircraft parked in excess of 90 minutes. These projections do not reflect rate increases, since they are uniform for all three airport categories. Also, like above, these projections reflect the projected level of aircraft operations, since MTOW calculations have not been developed in this Inception Report. Parking Fee charges are projected to increase from US$25,000 in 2006 to US$109,000 in 2028, or an average annual growth rate of 6.96%.

  Passenger Charges) – These charges are payable in US dollars and based on the level of departing passengers for scheduled and non-scheduled flights, with different rates applied to domestic, regional and international destinations. These projections reflect an average rate and projected passenger levels. As shown, Passenger Charges are projected to increase from US$242,000 to 2006 to US$5,536,000 in 2028, corresponding to a 15.3% average annual growth rate.

- **Cargo Charges)** – These charges are payable in US dollars and based on the weight (kg) of the cargo and mail loaded and unloaded at the airport. These projections reflect the current rate and the projected cargo and mail traffic. As shown, Cargo Charges increase from US$10,000 in 2006 to US$43,000 in 2028, or a 6.72% average annual growth rate.

- **Air Navigation Charges)** – These charges are payable in US dollars and based on the MTOW for aircraft that are arriving or departing and serviced by the control tower facilities at Pemba Airport. As with Landing Charges and Parking Charges, these projections reflect projected aircraft operations because MTOW have not been projected elsewhere in the Inception Report. As shown, Air Navigation charges are projected to increase from US$85,000 in 2006 to US$372,000 in 2028, corresponding to a 6.96% average annual growth rate.

- **Usage Charges)** – These charges are payable in US dollars and based on percentages of the gross revenues of the service providers at the airport, such as terminal concessionaires. These projections are based on projected rate increases and passenger levels, since details of the terminal concession program have not been developed at this point. As shown, Usage Charges are projected to increase from US$9,000 in 2006 to US$3,590,000 in 2028, corresponding to a 31.53% average annual growth rate.

- **Rental Charges)** – These charges are payable in local currency and based on rentable space in the terminal and other airport facilities. These projections reflect the current rate and space through 2009 while the new facilities are being developed, and higher rates and expanded space after 2010 when the phased development program occurs. As shown, Rental Charges are projected to increase

from US$42,000 in 2006 to US$2,529,000 in 2028, or a 20.53% average annual growth rate.

- **Miscellaneous Charges)** – Miscellaneous Service Charges, including fuel throughput fees, are payable in US dollars and are based on hectoliters of aviation fuel sold to aircraft using Pemba airport. Since aviation fuel has not been projected elsewhere in the Inception Report, these projections reflect the projected aircraft operations throughout the 2006 through 2028 projection period. As shown, Other Service Charges are projected to increase from US$3,000 in 2006 to US$203,000 in 2028, corresponding to a 21.95% average annual growth rate.

- **Other Service Charges**) – Other Service Charges, representing various non-recurring income sources, are payable in local currency. These projections are based on inflation only, and increase from US$13,000 in 2006 to US$54,000 in 2028, or a 6.50% average annual growth rate.

Pemba Airport Expense Projections

Pemba Airport's operating expenses in 2006 were provided by ADM and are projected to increase from US$354,000 in 2006 to US$3,288,000 in 2028, representing an average annual growth rate of 10.66%. On an enplaned passenger basis, Operating Expense increased from US$7.83 in 2006 to US$16.50 in 2028, or an average annual growth rate of 3.44%.

In general, each of these Operating Expense projections reflect inflation which, as with Operating Revenues, is applied at five year intervals at the compounded rate of 17.34%, corresponding to 50% of the recent annual inflation rate of 6.50%, over the 2006 through 2028 projection period; inflation is not necessarily mentioned again below. Also, these Operating Expense projections reflect growth in operations, employees and facilities, whichever is relevant. Pemba Airport has five expense elements, and the assumptions used to develop projections for each element are reviewed below:

- **Personnel Costs)** – Personnel Costs are payable in local currency and based on the number and level of employees. Exhibits 4-2A and 4-2B represent two Organization Charts for Pemba Airport. Both charts show the functions, with the present functions displayed in green and the new function (Terminal Custodial Maintenance) displayed in yellow. The top chart reflects the present staffing levels, with 31 employees distributed among eight departments. The bottom chart reflects the projected staffing level, with an increase to 70 employees distributed among nine departments; overall, this arrangement assumes that there would be three shifts of eight hours per day, with each department (except Airport Manager) having at least one staff per shift, as follows:

○ Airport Manager	1 employee	= 1
○ Administration	3 shifts x 1 employee	= 3
○ Control Tower	3 shifts x 4 employees	= 12

o Flight Information	3 shifts x 1 employee	= 3
o Fire fighters	3 shifts x 8 employees	= 24
o Electronics Maintenance	3 shifts x 1 employee	= 3
o Electrical Maintenance	3 shifts x 2 employees	= 6
o Civil Works Maintenance	3 shifts x 2 employees	= 6
o Terminal Custodial Maintenance	3 shifts x 4 employees	= 12
o Total Employees		= 70

As such, personnel costs are projected to increase from US$ 270,000 in 2006 to US$2,435,000 in 2028, representing an average annual growth rate of 10.52%.

- **Supply Costs)** – Supply Costs, representing the procurement of all of the materials consumed by the departments of the airport, are payable in local currency. Since the various components have not been provided by ADM, these projections are based on projected traffic operations. As shown, Supply Costs are projected to increase from US$54,000 in 2006 to US$499,000 in 2028, corresponding to a 10.64% average annual growth rate.

- **Contract Services Costs)** – Contract Service Costs, representing the outsourcing of all services not provided by the airport or ADM, are payable in local currency. Again, since ADM has not provided details, these projections are based on projected traffic operations. As shown Contract Service Costs are projected to increase from US$23,000 in 2006 to US$217,000 in 2028, or a 10.64% average annual growth rate.

- **Finance Costs)** – Finance Costs represent charges associated with financial activities such as banking and are payable in local currency; interest costs on external borrowing for the development program, will not be included in this expense category, but alternatively will be included in the cash flow projections as a separate line item. Since ADM has not provided details, the projections are based on inflation only. Finance Costs are projected to increase from less US$1,000 in 2006 to US$4,000 in 2028, corresponding to a 6.50% average annual growth rate.

- **Administrative Fees)** – Administrative Fees represent the charge that Pemba Airport pays to ADM for services provided, including centralized accounting, legal and personnel activities. The Administrative Fees are 1% of the airport's Operating Revenues, as established by ADM. As such, this expense is projected to increase from US$6,000 in 2006 to US$133,000 in 2028, or a 14.88% average annual growth rate.

Pemba Airport Cash Flow Projections and NPV and IRR Calculations

This Section of the Report presents the financial outcome for Pemba Airport. It also presents measures of financial performance that will enable ADM to compare the financial outcomes for both Pemba and Nacala Airports and will assist ADM in

determining which airport to select for upgrade to International Status. These financial elements include Net Cash Flow (NCF), Weighted Average Cost of Capital (WACC), Net Present Value (NPV) and Internal Rate of Return (IRR), each of which is discussed below:

- **Net Cash Flow (NCF)** – The Net Cash Flow represents the combination of Operating Revenues, Operating Expenses and Financing Requirements developed previously in this Section. The NCF for Pemba Airport is a positive value of US$42,213,000 over the 2006-2028 period, indicating that the development program is affordable, although it does not take into consideration the time-adjusted value of the development program. The WACC, NPV and IRR, discussed below, are measures of financial performance which overcome this deficiency.

- **Weighted Average Cost of Capital (WACC)** – The WACC represents the cost associated with the financing of the development program and the element that is necessary to determine the NPV and IRR, overcoming the deficiency noted above. This cost has been determined by blending the actual cost of the external borrowing (8.5%) and the opportunity cost of the ADM contribution (18%), and weighting these costs by the proportions borrowed (70%) and contributed (30%), respectively. The external borrowing component is 5.95%, representing the interest rate times the borrowing share (7.5% x 70%). The airport contribution component is 5.40%, representing the target return that it is assumed ADM would require on its investment times the airport contribution share (18% x 30%). The WACC was determined to be 11.35% (5.95% plus 5.40%).

- **Net Present Value (NPV)** – The NPV, representing the Net Cash Flow discounted by the WACC, was determined to be a positive value of US$2,682,000 over the 2006-2028 period. This performance measure indicates that the development program is affordable, even after taking into consideration the cost of financing the development program. It is possible for the Net Present Value to be a negative value, meaning that the development program would not be affordable. Another performance measure addressing this issue is Internal Rate of Return, which is discussed below.

- **Internal Rate of Return (IRR)** - The IRR represents the discount rate that would equate the present value of the inflows with the present value of the outflows. The IRR was determined to be 16.12% over the 2006-2028 period. Note that the IRR of 16.12% exceeds the WAAC of 11.35%, which happens whenever the NPV is positive and indicates that the investment would be justified. An IRR lower than the WACC would occur whenever the NPV is negative and would indicate that the investment would not be justified. An important point to note, however, is that the IRR of 16.12% does not satisfy ADM's target investment rate objective of 18%.

In conclusion, the foregoing financial analysis has demonstrated that ADM would be justified in developing Pemba Airport, if it represented the only airport under consideration. The same financial analysis for Nacala Airport, and the measures of

financial performance for the two airports are compared in Section 6.4 in order to assist ADM in determining which of the two airports would be preferable to select for the upgrade to International Status.

4.3.2 Nacala Airport

This section presents the financial analysis for Nacala Airport and includes subsections regarding finance plan, Operating Revenue projections, Operating Expense projections, cash flow projections and NPV and IRR calculations.

Nacala Airport Finance Plan

Table 4-4 presents Nacala Airport's financing plan. This table consists of three components. First, the capital cost requirements developed elsewhere in the Inception Report are summarized, amounting to a total of US$23,690,000 and staged over the 2009 through 2028 period. Second, the funding sources for these costs are developed, consisting of US$7,107,000 of airport contributions (30%) and US$ 16,583,000 of external borrowing (70%); the external borrowings reflect a series of term loans, each with 8.5% interest rates and 15 year repayment terms, consistent with lending parameters of the African Development Bank. Third, the debt service requirements are determined, including US$8,509,000 of interest and US$9,786,000 of principal occurring over the 2009 through 2028 period; the outstanding principal balance would be US$6,797,000 as of 2028. These airport contributions, interest requirements and principal requirements will be used in the cash flow projections, as well as the NPV and IRR calculations, presented later in this Section of the Inception Report.

Nacala Airport Operating Revenue Projections

Nacala Airport would not commence operations until 2010. Nacala Airport's Operating Revenues for that time would be consistent with those of Pemba Airport in 2010, with adjustments reflecting the differences in aviation traffic projection for the two airports in 2010. As shown, Operating Revenues are projected to increase from US$940,000 in 2010 to US$14,477,000 in 2028, representing an average annual growth rate of 16.41%. On a per enplaned passenger basis, Operating Revenues increase from US$28.47 in 2010 to US$63.63 in 2028, or an average annual growth rate of 4.57%.

In general, each of these Operating Revenue projections reflect inflation, which is applied at five-year intervals at the compounded rate of 17.34%, corresponding to 50% of the recent annual inflation rate of 6.50%, over the 2010 through 2028 projection period; inflation is not necessarily mentioned again below. Also, these revenue projections reflect growth in aviation traffic and aeronautical facilities, whichever is relevant. Nacala Airport has nine revenue elements, and the assumptions used to develop projections for each element are reviewed below:

- **Landing Fees)** – These charges are payable in US dollars and based on the maximum take-off weight (MTOW) of aircraft arrivals, with different rates applicable to three categories of airports. These projections do not reflect rate increases because Nacala Airport, unlike Pemba Airport, would be included in the Airport category throughout the 2010 to 2026 projection period, as explained in previously in this Section of the Inception Report. Also, these projections reflect the level of aircraft operations each year, since the traffic forecasts do not include calculation of MTOW. Landing Fee charges are projected to increase from US$66,000 in 2010 to US$756,000 in 2028, corresponding to a 14.53% average annual growth rate.

- **Parking Charges)** – These charges, likewise, are payable in US dollars and based on MTOW for aircraft parked in excess of 90 minutes. These projections do not reflect rate increases, since the airport category would not change as mentioned above and they are uniform for all three airport categories as well. Also, like above, these projections reflect the projected level of aircraft operations, since MTOW calculations have not been developed in this Inception Report. Parking Fee charges are projected to increase from US$8,000 in 2010 to US$93,000 in 2028, or an average annual growth rate of 14.53%.

- **Passenger Charges)** – These charges are payable in US dollars and based on the level of departing passengers for scheduled and non-scheduled flights, with different rates applied to domestic, regional and international destinations. These projections reflect an average rate and projected passenger levels. As shown, Passenger Charges are projected to increase from US$304,000 in 2010 to US$6,321,000 in 2028, corresponding to a 18.37% average annual growth rate.

- **Cargo Charges)** – These charges are payable in US dollars and based on the weight (kg) of the cargo and mail loaded and unloaded at the airport. These projections reflect the current rate and the projected cargo and mail traffic. As shown, Cargo Charges increase from US$12,000 in 2010 to US$43,000 in 2028, or a 7.31% average annual growth rate.

- **Air Navigation Charges)** – These charges are payable in US dollars and based on the MTOW for aircraft that are arriving or departing and serviced by the control tower facilities at Nacala Airport. As with Landing Charges and Parking Charges, these projections reflect projected aircraft operations because MTOW have not been projected elsewhere in the Inception Report. As shown, Air Navigation charges are projected to increase from US$28,000 in 2010 to US$317,000 in 2028, corresponding to a 14.53% average annual growth rate.

- **Usage Charges)** – These charges are payable in US dollars and based on percentages of the gross revenues of the service providers at the airport, such as terminal concessionaires. These projections are based on projected rate increases and passenger levels, since details of the terminal concession program have not been developed at this point. As shown, Usage Charges are projected to increase

from US$104,000 in 2010 to US$4,099,000 in 2028, corresponding to a 22.13% average annual growth rate.

- **Rental Charges)** – These charges are payable in local currency and based on rentable space in the terminal and other airport facilities. These projections reflect increased higher rates and expanded space from 2010 through 2028 when the staged development program occurs. As shown, Rental Charges are projected to increase from US$398,000 in 2010 to US$2,673,000 in 2028, or a 11.16% average annual growth rate.

- **Miscellaneous Charges)**– Miscellaneous Service Charges, representing fuel throughput fees, are payable in US dollars and are based on hectoliters of aviation fuel sold to aircraft using Nacala Airport. Since aviation fuel has not been projected elsewhere in the Inception Report, these projections reflect the projected operations throughout the 2010 through 2028 projection period. As shown, Other Service Charges are projected to increase from US$3,000 in 2010 to US$122,000 in 2028, corresponding to a 22.13% average annual growth rate.

- **Other Service Charges**) – Other Service Charges, representing various non-recurring income sources, are payable in local currency. These projections are based on inflation only, and increase from US$17,000 in 2010 to US$54,000 in 2028, a 6.50% average annual growth rate.

Nacala Airport Expense Projections

Nacala Airport's Operating Expense projections commence in 2010 and would be consistent with those of Pemba Airport in 2010, with adjustments reflecting the differences in aviation traffic projection for the two airports in 2010. Total Operating Expenses increase from US$822,000 in 2010 to US$3,194,000 in 2028, representing an average annual growth rate of 7.83%. On a per enplaned passenger basis, Operating Expenses decrease from US$24.89 in 2010 to US$14.04 in 2028, or an average annual growth rate of minus 3.13%.

In general, each of these expense projections reflect inflation which, as with Operating Revenues, is applied at five-year intervals at the compounded rate of 17.34%, corresponding to 50% of the recent annual inflation rate of 6.50%, over the 2010 through 2028 projection period; inflation is not necessarily mentioned again below. Also, these expense projections reflect growth in operations, employees and facilities, whichever is relevant. Nacala Airport has four expense elements, and the assumptions used to develop projections for each element are reviewed below:

- **Personnel Costs)** – Personnel Costs are payable in local currency and based on the number and level of employees. Exhibits 4-3A and 4-3B represents two Organization Charts for Nacala Airport. The top chart reflects 2010, the first year of operation, while the bottom chart reflects 2014, four years thereafter. Otherwise, both charts are the same showing nine functions and the proposed employees for

each function. These staffing levels assume that there would be three shifts of eight hours per day, with each department (except Airport Manager) having at least one staff per shift, as follows:

o Airport Manager	1 employee	= 1
o Administration	3 shifts x 1 employee	= 3
o Control Tower	3 shifts x 4 employees	= 12
o Flight Information	3 shifts x 1 employee	= 3
o Fire fighters	3 shifts x 8 employees	= 24
o Electronics Maintenance	3 shifts x 1 employee	= 3
o Electrical Maintenance	3 shifts x 2 employees	= 6
o Civil Works Maintenance	3 shifts x 2 employees	= 6
o Terminal Custodial Maintenance	3 shifts x 4 employees	= 12
o Total Employees		= 70

Personnel costs are projected to increase from US$784,000 in 2010 to US$2,435,000 in 2028, representing an average annual growth rate of 6.50%.

- **Supply Costs)** – Supply Costs, representing the procurement of all of the materials consumed by the departments of the airport, are payable in local currency. Since the various components have not been provided by ADM, these projections are based on projected traffic operations. As shown, supply costs are projected to increase from US$19,000 in 2010 to US$426,000 in 2028, corresponding to a 18.76% average annual growth rate.

- **Contract Service Costs)** – Contract Service Costs, representing the outsourcing of all of the services not provided by the airport or ADM, are payable in local currency. Again, since ADM has not provided details, these projections are based on projected traffic operations. As shown Contract Service Costs are projected to increase from US$8,000 in 2010 to US$185,000 in 2028, or a 18.76% average annual growth rate.

- **Finance Costs)** – Finance Costs represent charges associated with financial activities such as banking and are payable in local currency; interest costs on external borrowing for the development program, will not be included in this expense category, but alternatively will be included in the cash flow projections as a separate line item. Since ADM has not provided details, the projections are based on inflation only. Finance Costs are projected to increase from US$1,000 in 2010 to US$4,000 in 2028, corresponding to a 6.50% average annual growth rate.

- **Administrative Fee)** – Administrative Fee cost represents the charge that the airport pays to ADM for services provided, including accounting and personnel activities. The Administrative Fee is 1% of the airport's Operating Revenues, as established by ADM. As such, this expense increases from US$9,000 in 2006 to US$145,000 in 2028, or a 16.41% average annual growth rate.

Nacala Airport Cash Flow Projections and NPV and IRR Calculations

This Section of the Report presents the financial outcome for Nacala Airport. It also presents measures of financial performance that will enable ADM to compare the financial outcomes for both Nacala and Pemba Airports and will assist ADM in determining which airport to select for upgrade to International Status. These financial performance measures include Net Cash Flow (NCF), Weighted Average Cost of Capital (WACC), Net Present Value (NPV) and Internal Rate of Return (IRR), each of which is discussed below:

- **Net Cash Flow (NCF)** – The NCF for Nacala Airport represents the combination of Operating Revenues, Operating Expenses and Financing Requirements. The Net Cash Flow for Nacala Airport is a positive value of US$45,055,000 over the 2009-2028 period, indicating that the Development program is affordable, although this does not take into consideration of the time-adjusted value of financing the development program. The WACC, NPV and the IRR, discussed below, are measures of financial performance which overcome this deficiency.

- **Average Cost of Capital** – The WACC represents the cost associated with the financing of the development program and the element that is necessary to determine NPV and IRR, overcoming the deficiency noted above. This cost has been determined by blending the actual cost of the external borrowing (8.5%) and the opportunity cost of the Airport contribution (18%), and weighting these costs by the proportions borrowed (70%) and contributed (30%), respectively. The external borrowing component is 5.95%, representing the interest rate times the borrowing share (8.5% x 70%). The ADM contribution component is 5.40%, with the interest rate representing the target return that it is assumed ADM would require on its investment times the airport contribution share (18% x 30%). The Weighted Average Cost of Capital was determined to be 11.35% (5.95% plus 5.40%).

- **Net Present Value (NPV)** – The NPV, representing the NCF discounted by the WAAC, was determined to be a positive value of US$ 5,396,000 over the 2009-2028 period. This performance measure indicates that the development program is affordable even after taking into account the cost of financing the development program. It is possible for the Net Present Value to be a negative value, meaning that the development program would not be affordable. Another performance measure addressing this issue is Internal Rate of Return, which is discussed below.

- **Internal Rate of Return (IRR)** - The IRR represents the discount rate that would equate the present value of the inflows with the present value of the outflows. The IRR was determined to be 20.09% over the 2009-2028 period. Note that the IRR of 20.09% exceeds both the WAAC of 11.35%, which also occurred with Pemba Airport, and the target investment rate objective of 18%, which did not occur with Pemba Airport. This superior performance of Nacala Airport over Pemba Airport is discussed further in the final section below.

4.4 Summary and Conclusions

4.4.1 Financial Comparison

The foregoing financial analysis has demonstrated that ADM would be justified in selecting Nacala Airport for upgrade to International Status. It also has demonstrated that ADM would satisfy its target investment rate objective by selecting Nacala Airport over Pemba Airport for upgrading to International Status. The purpose of the final section below is to compare the outcomes for both airports, which is designed to assist ADM in determining which of the two airports would be the preferred selection by ADM for the development program.

Table 4.5 below presents a summary of the each of the three elements of the financial analysis approach as depicted in Exhibit 6-1 (Financial Analysis Approach) mentioned at the outset of this Section.

Table 4.3 Financial Performance Comparison

	Pemba	Nacala
Traffic Forecasts		
Enplaned Passengers	2,372,000	2,282,000
Aircraft Operations	218,000	135,000
Cargo/Mail Weight (kg)	35,000	27,000
Facility Requirements (US$)		
Project Cost	18,198,000	23,690,000
Airport Contribution	5,459,000	7,107,000
External Borrowing	12,738,000	16,583,000
Principal Repaid	10,365,000	9,785,000
Principal Outstanding (2028)	2,374,000	6,797,000
Interest Paid	8,563,000	8,510,000
Financial Projections (US$)		
Operating Revenues	103,189,000	101,267,000
Operating Expenses	36,590,000	33,374,000
Net Present Value	2,682,000	5,396,018
Internal Rate of Return	16.12%	20.09%
Average Cost of Capital	11.35%	11.35%
ADM Target Investment Rate	18.00%	18.00%

4.4.3 Revenue Enhancements

It should be noted that the comparative financial feasibility analysis presented in the present Section of this report is based on the current sources of Operating Revenues and Operating Expenses. The detailed financial analysis of the selected option that appears in Section 11 of this report examines opportunities for introducing Operating Revenue enhancements, such as charges related to land development activities, charges generated by new facilities, etc.

Exhibit 4-1: Financial Analysis Approach

Traffic Forecasts:

- Operations
- Passengers
- Cargo & Mail

Facility Requirements:

- Terminal
- Runway & Taxiway
- Ramps
- Hangars
- Roads & Utilities
- Automobile Parking
- Other

Financing Plan:

- Airport Contribution
- External Borrowing

Operating Revenue Projections:

- Aircraft Related Charges
- Passenger Related Charges
- Other Air Traffic Charges
- Ground Handling Charges
- Concessions
- Rentals
- Other Revenues

Operating Expense Projections:

- Personnel Costs
- Supplies
- Contracted Services
- Administrative Overheads
- Other Expenses

Cash Flow Projections:

- Plus: Operating Revenues
- Minus: Operating Expenses
- Minus: Airport Contribution
- Minus: Debt Service - Interest
- Minus: Debt Service - Principal
- Equals: Net Cash Flow
- Equals: Net Present Value (NPV)
- Equals: Internal Rate of Return (IRR)

Exhibit 4-2A: Pemba Airport Current Organization Chart (2006) 31 Total Employees

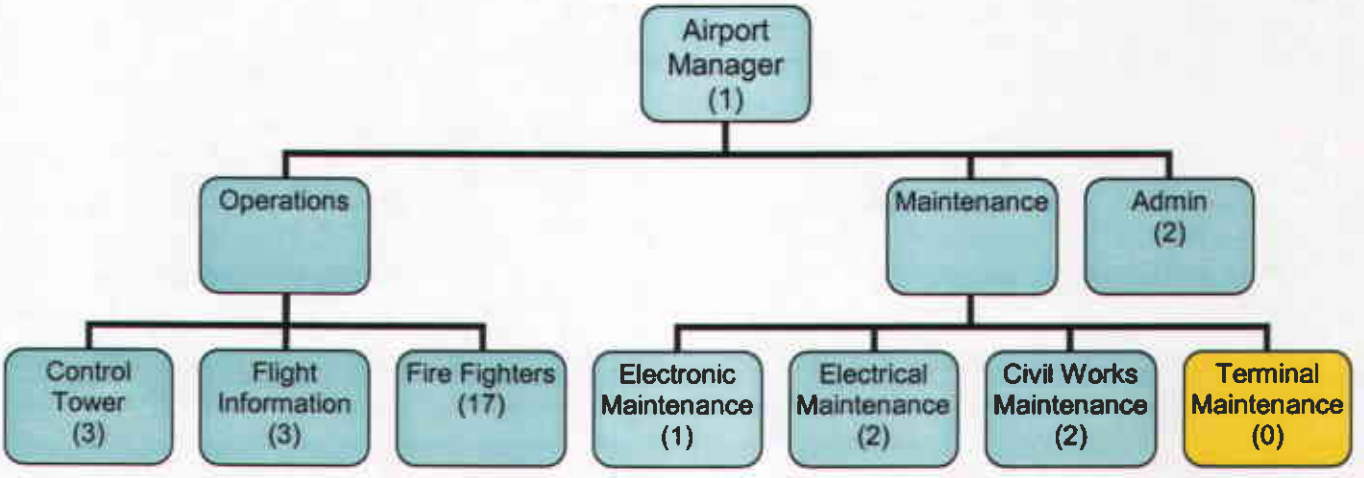


Exhibit 4-2B: Pemba Airport Future Organization Chart (2010) 70 Total Employees

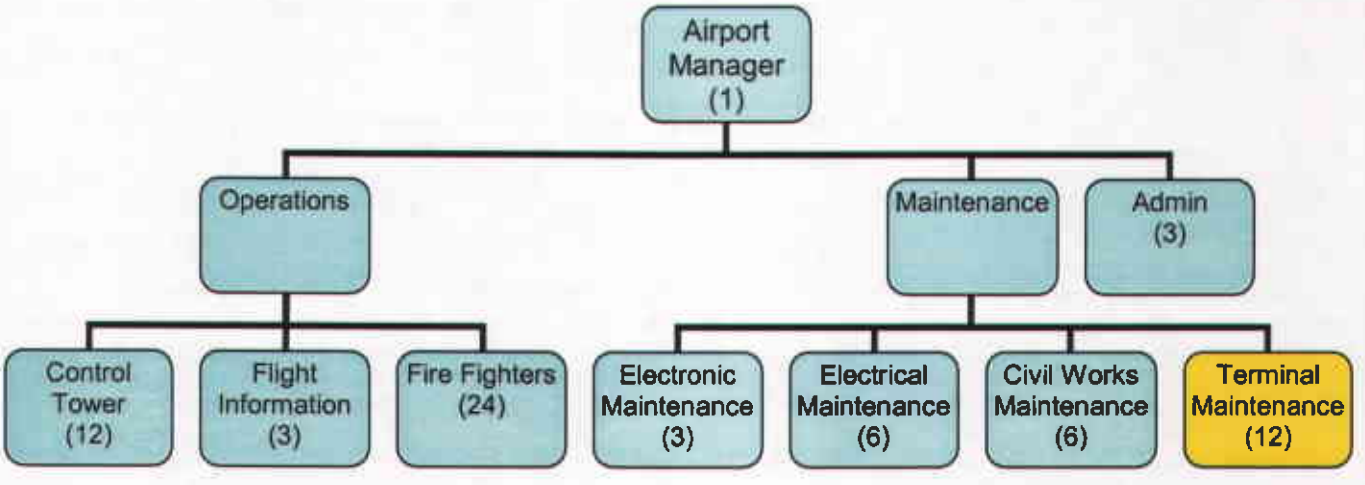


Exhibit 4-3A: Nacala Airport Initial Organization Chart (2008) 70 Total Employees

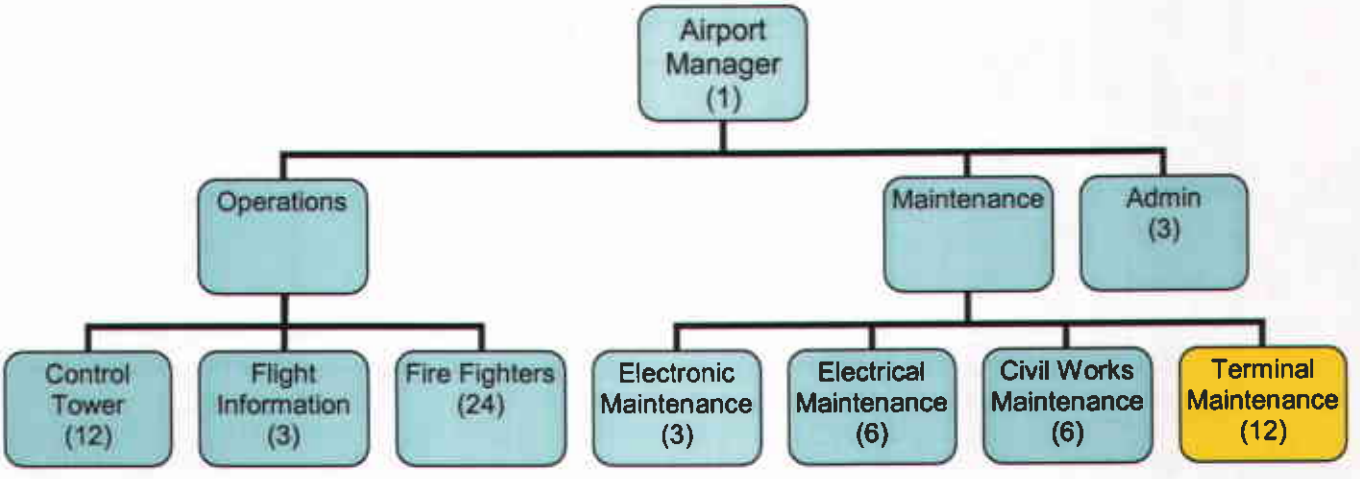
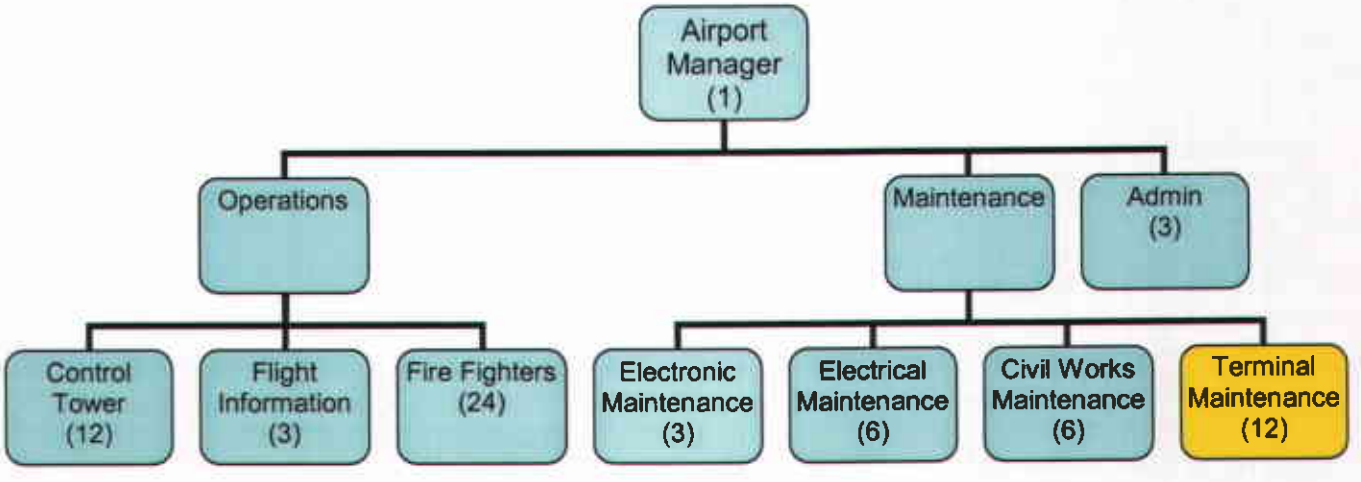


Exhibit 4-3B: Nacala Airport Future Organization Chart (2010) 70 Total Employees



Airports of Mozambique
Feasibility Study for the Expansion of Pemba or Nacala

Table 4-3
Pemba Airport Preliminary Financing Plan

	Actual 2006	Forecast 2007	Forecast 2008	Forecast 2009	Forecast 2010	Forecast 2011	Forecast 2012	Forecast 2013	Forecast 2014	Forecast 2015	Forecast 2016	Forecast 2017	Forecast 2018	Forecast 2019	Forecast 2020	Forecast 2021	Forecast 2022	Forecast 2023	Forecast 2024	Forecast 2025	Forecast 2026	Forecast 2027	Forecast 2028	
Development Costs																								
Airside	$ -	$ -	$ 1,327,161	$ -	$ -	$ -	$ -	$ 1,769,548	$ -	$ -	$ -	$ -		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,327,161	
Runway Extension	$ -	$ -	$ 5,750,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	
Landside	$ -	$ -	$ 220,632	$ -	$ -	$ -	$ -	$ 294,176	$ -	$ -	$ -	$ -		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 220,632	
Navaids & Equipment	$ -	$ -	$ 145,763	$ -	$ -	$ -	$ -	$ 194,350	$ -	$ -	$ -	$ -		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 145,763	
Departure Lounge Renovation	$ -	$ -	$ 4,500,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	
Repairing	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,151,178	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,151,178	
Total Development Costs	$ -	$ -	$ 11,943,556	$ -	$ -	$ -	$ -	$ 2,258,074	$ -	$ -	$ -	$ -	$ 1,151,178	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 2,844,734	
Financing Plan																								
Debt (70%)	$ -	$ -	$ 8,360,489	$ -	$ -	$ -	$ -	$ 1,580,652	$ -	$ -	$ -	$ -	$ 805,825	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,991,314	
Equity (30%)	$ -	$ -	$ 3,583,067	$ -	$ -	$ -	$ -	$ 677,422	$ -	$ -	$ -	$ -	$ 345,353	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 853,420	
Total Financing Sources	$ -	$ -	$ 11,943,556	$ -	$ -	$ -	$ -	$ 2,258,074	$ -	$ -	$ -	$ -	$ 1,151,178	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 2,844,734	
																								2028 Outstanding Balance
Debt Service Requirements - 2009 Projects:																								
Interest Requirement	$ -		$ -	$ 710,842	$ 685,470	$ 658,160	$ 628,527	$ 596,376	$ 561,493	$ 523,644	$ 482,578	$ 438,021	$ 389,677	$ 337,224	$ 280,312	$ 218,562	$ 151,564	$ 78,872	$ -	$ -	$ -	$ -	$ -	
Principal Requirement	$ -		$ -	$ 296,132	$ 321,304	$ 348,814	$ 378,247	$ 410,398	$ 445,281	$ 483,130	$ 524,196	$ 568,753	$ 617,097	$ 669,550	$ 726,462	$ 788,211	$ 855,209	$ 927,902	$ -	$ -	$ -	$ -	$ -	
Phase I Balance Outstanding	$ -		$ 8,360,489	$ 8,064,357	$ 7,743,053	$ 7,394,438	$ 7,016,192	$ 6,605,794	$ 6,160,513	$ 5,677,383	$ 5,153,186	$ 4,584,433	$ 3,967,336	$ 3,297,785	$ 2,571,323	$ 1,783,112	$ 927,902	$ (0)	$ (0)	$ (0)	$ (0)	$ (0)	$ (0)	$ (0)
Debt Service Requirements 2013 Projects:																								
Interest Requirement	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 134,355	$ 129,598	$ 124,433	$ 118,831	$ 112,752	$ 106,157	$ 99,001	$ 91,237	$ 82,813	$ 73,673	$ 63,756	$ 52,996	$ 41,322	$ 28,655	$ 14,912	
Principal Requirement	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 55,987	$ 60,746	$ 65,910	$ 71,512	$ 77,581	$ 84,186	$ 91,342	$ 99,106	$ 107,530	$ 116,670	$ 126,587	$ 137,346	$ 149,021	$ 161,688	$ 175,431	
Phase II Balance Outstanding	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,580,652	$ 1,524,664	$ 1,463,918	$ 1,398,008	$ 1,326,496	$ 1,248,905	$ 1,164,720	$ 1,073,378	$ 974,272	$ 866,743	$ 750,073	$ 623,486	$ 486,140	$ 337,119	$ 175,431	$ (0)	$ (0)
Debt Service Requirements 2018 Projects:																								
Interest Requirement	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 68,495	$ 66,069	$ 63,437	$ 60,581	$ 57,482	$ 54,119	$ 50,471	$ 46,513	$ 42,219	$ 37,559	
Principal Requirement	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 28,543	$ 30,969	$ 33,501	$ 36,457	$ 39,556	$ 42,918	$ 46,566	$ 50,525	$ 54,819	$ 59,479	
Phase II Balance Outstanding	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 805,825	$ 777,282	$ 746,313	$ 712,712	$ 676,255	$ 636,699	$ 593,780	$ 547,214	$ 496,689	$ 441,870	$ 382,391	$ 382,391
Debt Service Requirements 2028 Projects:																								
Interest Requirement	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	
Principal Requirement	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	
Phase II Balance Outstanding	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,991,314	$ 1,991,314
																								$ 2,373,705

Source: AARROTEC Infrastructure Group, Inc.

Table 6-2
Pemba Airport Operating Revenue Projections

Operating Revenues:	Forecast Factors	Actual 2006	Forecast 2007	Forecast 2008	Forecast 2009	Forecast 2010	Forecast 2011	Forecast 2012	Forecast 2013	Forecast 2014	Forecast 2015	Forecast 2016	Forecast 2017	Forecast 2018	Forecast 2019	Forecast 2020	Forecast 2021	Forecast 2022	Forecast 2023	Forecast 2024	Forecast 2025	Forecast 2026	Forecast 2027	Forecast 2028	Average Annual Growth Rate (%)
Aeronautical Revenues:																									
Taxes - Aircraft Landing Fees	Aircraft Operations & Inflation	$ 202,001	$ 185,056	$ 192,891	$ 201,045	$ 245,923	$ 260,125	$ 274,851	$ 290,009	$ 303,478	$ 372,660	$ 380,178	$ 405,176	$ 420,984	$ 437,717	$ 534,355	$ 556,326	$ 579,681	$ 604,494	$ 630,893	$ 773,318	$ 808,583	$ 846,322	$ 888,718	6.98%
Taxes - Aircraft Parking Fees	Aircraft Operations & Inflation	$ 24,854	$ 22,769	$ 23,734	$ 24,737	$ 30,259	$ 32,008	$ 33,818	$ 35,694	$ 37,340	$ 45,855	$ 48,008	$ 49,853	$ 51,796	$ 53,857	$ 65,748	$ 68,451	$ 71,326	$ 74,378	$ 77,626	$ 95,150	$ 99,489	$ 104,132	$ 109,103	6.96%
Taxes - Passenger Fees	Enplaned Passengers & Inflation	$ 241,703	$ 254,949	$ 394,917	$ 416,891	$ 516,603	$ 558,696	$ 612,056	$ 848,696	$ 904,785	$ 1,132,898	$ 1,210,082	$ 1,361,277	$ 1,617,644	$ 1,724,094	$ 2,158,410	$ 2,305,576	$ 2,465,847	$ 2,987,235	$ 3,203,188	$ 4,035,773	$ 4,339,370	$ 4,872,407	$ 5,536,498	15.30%
Taxes - Cargo & Mail Fees	Cargo & Mail Weight & Inflation	$ 10,237	$ 10,467	$ 11,402	$ 12,337	$ 15,560	$ 16,857	$ 17,754	$ 18,637	$ 19,034	$ 24,678	$ 25,949	$ 27,238	$ 28,523	$ 29,292	$ 36,471	$ 36,471	$ 36,471	$ 36,471	$ 36,471	$ 42,795	$ 42,795	$ 42,795	$ 42,795	6.72%
Area Navigation Fees	Aircraft Operations & Inflation	$ 84,720	$ 77,614	$ 80,900	$ 84,320	$ 103,141	$ 109,098	$ 115,274	$ 121,689	$ 127,281	$ 156,304	$ 163,643	$ 169,933	$ 176,555	$ 183,581	$ 224,112	$ 233,327	$ 243,125	$ 253,528	$ 264,600	$ 324,334	$ 339,124	$ 354,952	$ 371,894	8.98%
Usage Fees	Enplaned Passengers, Rates & Inflation	$ 6,642	$ 6,115	$ 135,912	$ 143,052	$ 177,267	$ 191,712	$ 210,021	$ 410,318	$ 437,436	$ 547,722	$ 585,038	$ 658,136	$ 910,891	$ 970,712	$ 1,215,244	$ 1,298,103	$ 1,388,340	$ 1,833,357	$ 1,965,894	$ 2,476,877	$ 2,863,203	$ 2,887,598	$ 3,590,361	31.53%
Non-Aeronautical Revenues:																									
Rental Fees	Terminal Space, Rates & Inflation	$ 41,555	$ 41,555	$ 74,555	$ 74,555	$ 87,483	$ 87,483	$ 87,483	$ 334,066	$ 334,066	$ 391,993	$ 391,993	$ 391,993	$ 782,465	$ 782,465	$ 918,145	$ 918,145	$ 918,145	$ 1,146,148	$ 1,146,148	$ 1,344,891	$ 1,344,891	$ 1,344,891	$ 2,528,517	20.53%
Miscellaneous Fees	Aircraft Operations, Rates & Inflation	$ 2,584	$ 2,752	$ 2,931	$ 3,121	$ 3,324	$ 3,540	$ 3,770	$ 79,078	$ 84,218	$ 89,892	$ 95,522	$ 101,731	$ 108,343	$ 115,386	$ 122,886	$ 130,873	$ 139,360	$ 148,440	$ 158,088	$ 168,384	$ 179,308	$ 190,963	$ 203,375	21.95%
Other Revenues	Inflation	$ 13,477	$ 14,353	$ 15,285	$ 16,279	$ 17,337	$ 18,464	$ 19,664	$ 20,942	$ 22,304	$ 23,753	$ 25,297	$ 26,942	$ 28,693	$ 30,556	$ 32,544	$ 34,660	$ 36,913	$ 39,312	$ 41,867	$ 44,588	$ 47,487	$ 50,573	$ 53,861	6.50%
Total Revenues		$ 629,772	$ 618,630	$ 932,127	$ 976,338	$ 1,196,896	$ 1,277,782	$ 1,374,691	$ 2,159,401	$ 2,270,842	$ 2,785,575	$ 2,935,709	$ 3,192,277	$ 4,126,074	$ 4,337,662	$ 5,307,914	$ 5,581,935	$ 5,879,237	$ 7,123,363	$ 7,524,776	$ 9,308,091	$ 9,864,248	$ 10,474,633	$ 13,323,121	14.88%
Total Revenues/Enplaned Passengers		$ 13.92	$ 12.96	$ 18.51	$ 18.37	$ 21.32	$ 21.05	$ 20.67	$ 29.77	$ 29.37	$ 33.78	$ 33.31	$ 32.20	$ 41.40	$ 40.74	$ 48.84	$ 46.11	$ 45.41	$ 51.38	$ 50.61	$ 58.30	$ 57.47	$ 56.68	$ 86.85	7.39%
Total Passenger Fees/Enplaned Passengers		$ 5.34	$ 5.34	$ 7.84	$ 7.84	$ 9.20	$ 9.20	$ 9.20	$ 11.70	$ 11.70	$ 13.73	$ 13.73	$ 13.73	$ 16.23	$ 16.23	$ 19.05	$ 19.05	$ 19.05	$ 21.55	$ 21.55	$ 25.28	$ 25.28	$ 25.28	$ 27.78	7.78%
Total Usage Fees/Enplaned Passengers		$ 0.19	$ 0.19	$ 2.69	$ 2.69	$ 3.16	$ 3.16	$ 3.16	$ 5.66	$ 5.66	$ 6.64	$ 6.64	$ 6.64	$ 9.14	$ 9.14	$ 10.72	$ 10.72	$ 10.72	$ 13.22	$ 13.22	$ 15.52	$ 15.52	$ 15.52	$ 18.02	22.96%
Total Rental Fees/Rentable Space		$ 62.95	$ 62.95	$ 112.96	$ 112.96	$ 132.55	$ 132.55	$ 132.55	$ 182.55	$ 182.55	$ 214.20	$ 214.20	$ 214.20	$ 264.20	$ 264.20	$ 310.02	$ 310.02	$ 310.02	$ 360.02	$ 360.02	$ 422.44	$ 422.44	$ 422.44	$ 472.44	9.59%
Total Rental Fees - $/Sq.Ft. Equivalt	10.7564	$ 5.85	$ 5.85	$ 10.50	$ 10.50	$ 12.32	$ 12.32	$ 12.32	$ 16.97	$ 16.97	$ 19.91	$ 19.91	$ 19.91	$ 24.56	$ 24.56	$ 28.82	$ 28.82	$ 28.82	$ 33.46	$ 33.46	$ 39.27	$ 39.27	$ 39.27	$ 43.91	9.59%

Source: ARROTEC Infrastructure Group, Inc.

Table 6-3
Pemba Airport Operating Expense Projections

Operating Expenses:	Forcast Factors	Actual 2006	Forecast 2007	Forecast 2008	Forecast 2009	Forecast 2010	Forecast 2011	Forecast 2012	Forecast 2013	Forecast 2014	Forecast 2015	Forecast 2016	Forecast 2017	Forecast 2018	Forecast 2019	Forecast 2020	Forecast 2021	Forecast 2022	Forecast 2023	Forecast 2024	Forecast 2025	Forecast 2026	Forecast 2027	Forecast 2028	Average Annual Growth Rate (%)
Salaries & Benefits	Employees & Inflation	$ 269,823	$ 287,382	$ 306,040	$ 325,933	$ 783,817	$ 834,765	$ 889,024	$ 846,811	$ 1,008,354	$ 1,073,897	$ 1,143,700	$ 1,218,040	$ 1,297,213	$ 1,381,532	$ 1,471,331	$ 1,566,968	$ 1,668,821	$ 1,777,294	$ 1,892,818	$ 2,015,852	$ 2,146,882	$ 2,285,429	$ 2,435,047	10.52%
Supply Costs	Aircraft Operations & Inflation	$ 53,949	$ 52,636	$ 56,431	$ 64,890	$ 72,008	$ 81,118	$ 91,281	$ 102,608	$ 114,317	$ 127,416	$ 142,059	$ 157,119	$ 173,852	$ 192,521	$ 213,314	$ 236,521	$ 262,473	$ 291,494	$ 323,998	$ 360,454	$ 401,388	$ 447,430	$ 499,258	10.84%
Service Fees	Aircraft Operations & Inflation	$ 23,452	$ 22,881	$ 25,400	$ 28,195	$ 31,303	$ 35,262	$ 39,680	$ 44,604	$ 49,695	$ 55,388	$ 61,758	$ 68,301	$ 75,575	$ 83,690	$ 92,729	$ 102,817	$ 114,099	$ 126,714	$ 140,844	$ 156,882	$ 174,488	$ 194,501	$ 217,031	10.64%
Financial Costs	Inflation	$ 891	$ 949	$ 1,011	$ 1,077	$ 1,147	$ 1,221	$ 1,301	$ 1,385	$ 1,475	$ 1,571	$ 1,673	$ 1,782	$ 1,898	$ 2,021	$ 2,152	$ 2,292	$ 2,441	$ 2,600	$ 2,789	$ 2,949	$ 3,141	$ 3,345	$ 3,562	6.50%
Administrative Fee	Revenues	$ 6,298	$ 6,186	$ 9,321	$ 9,763	$ 11,969	$ 12,778	$ 13,747	$ 21,594	$ 22,708	$ 27,856	$ 29,357	$ 31,923	$ 41,281	$ 43,277	$ 53,079	$ 55,819	$ 58,792	$ 71,234	$ 75,248	$ 93,081	$ 98,642	$ 104,746	$ 133,231	14.88%
Total Expenses		$ 354,414	$ 370,015	$ 400,204	$ 429,828	$ 900,243	$ 965,144	$ 1,035,033	$ 1,117,002	$ 1,196,549	$ 1,286,127	$ 1,378,557	$ 1,477,165	$ 1,589,799	$ 1,703,041	$ 1,832,606	$ 1,964,418	$ 2,106,626	$ 2,269,336	$ 2,435,678	$ 2,629,007	$ 2,824,539	$ 3,036,452	$ 3,288,129	10.86%
Total Expenses/Enplaned Passengers		$ 7.83	$ 7.75	$ 7.95	$ 8.09	$ 16.04	$ 15.90	$ 15.56	$ 15.40	$ 15.48	$ 15.59	$ 15.64	$ 14.90	$ 15.95	$ 16.03	$ 16.17	$ 16.23	$ 16.27	$ 16.37	$ 16.38	$ 16.47	$ 16.46	$ 16.43	$ 16.50	3.44%

Source: ARROTEC Infrastructure Group, Inc.

Table 6-4
Pemba Airport Cash Flow Projections

Cash Flow:	Actual 2006	Forecast 2007	Forecast 2008	Forecast 2009	Forecast 2010	Forecast 2011	Forecast 2012	Forecast 2013	Forecast 2014	Forecast 2015	Forecast 2016	Forecast 2017	Forecast 2018	Forecast 2019	Forecast 2020	Forecast 2021	Forecast 2022	Forecast 2023	Forecast 2024	Forecast 2025	Forecast 2026	Forecast 2027	Forecast 2028	Total 2006-2028
From Operations:																								
Operating Revenues	$ 629,772	$ 618,630	$ 932,127	$ 976,338	$ 1,196,896	$ 1,277,782	$ 1,374,691	$ 2,159,401	$ 2,270,842	$ 2,785,675	$ 2,935,709	$ 3,192,277	$ 4,126,074	$ 4,327,662	$ 5,307,914	$ 5,581,935	$ 5,679,237	$ 7,123,363	$ 7,524,776	$ 9,308,091	$ 9,864,248	$ 10,474,633	$ 13,323,121	$ 103,189,094
Less: Operating Expenses	$ (354,414)	$ (370,015)	$ (400,204)	$ (429,828)	$ (900,243)	$ (965,144)	$ (1,035,033)	$ (1,117,002)	$ (1,196,549)	$ (1,286,127)	$ (1,378,557)	$ (1,477,165)	$ (1,589,799)	$ (1,703,041)	$ (1,832,606)	$ (1,964,418)	$ (2,106,626)	$ (2,269,336)	$ (2,435,678)	$ (2,629,007)	$ (2,824,539)	$ (3,036,452)	$ (3,288,129)	$ (36,588,913)
From Development:																								
Less: Existing Debt Service - Principal & Interest	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Less: New Equity Requirement - 2009 Projects	$ -	$ -	$ (3,583,067)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ (3,583,067)
Lass: New Interest Requirement - 2009 Projects	$ -	$ -	$ -	$ (710,842)	$ (685,470)	$ (658,160)	$ (628,527)	$ (596,376)	$ (561,493)	$ (523,644)	$ (482,578)	$ (438,021)	$ (389,677)	$ (337,224)	$ (280,312)	$ (218,562)	$ (151,564)	$ (78,872)	$ -	$ -	$ -	$ -	$ -	$ (8,741,120)
Less: New Principal Requirement - 2009 Projects	$ -	$ -	$ -	$ (296,132)	$ (321,304)	$ (348,814)	$ (378,247)	$ (410,398)	$ (445,281)	$ (483,130)	$ (524,196)	$ (568,753)	$ (617,097)	$ (669,550)	$ (726,462)	$ (788,211)	$ (855,209)	$ (927,902)	$ -	$ -	$ -	$ -	$ -	$ (8,360,489)
Less: New Equity Requirement - 2013 Projects	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ (677,422)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ (677,422)
Less: New Interest Requirement - 2013 Projects	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ (134,355)	$ (129,598)	$ (124,433)	$ (118,831)	$ (112,752)	$ (106,157)	$ (99,001)	$ (91,237)	$ (82,813)	$ (73,673)	$ (63,756)	$ (52,996)	$ (41,322)	$ (28,655)	$ (14,912)	$ (1,274,490)
Less: New Principal Requirement - 2013 Projects	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ (55,987)	$ (60,746)	$ (65,910)	$ (71,512)	$ (77,581)	$ (84,186)	$ (91,342)	$ (99,106)	$ (107,530)	$ (116,670)	$ (126,587)	$ (137,346)	$ (149,021)	$ (161,688)	$ (175,431)	$ (1,580,652)
Less: New Equity Requirement - 2018 Projects	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ (345,353)											$ (345,353)
Less: New Interest Requirement - 2018 Projects	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ (68,495)	$ (66,069)	$ (63,437)	$ (60,581)	$ (57,482)	$ (54,119)	$ (50,471)	$ (46,513)	$ (42,219)	$ (37,559)	$ (546,944)
Less: New Principal Requirement - 2018 Projects	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ (28,543)	$ (30,969)	$ (33,501)	$ (36,457)	$ (39,556)	$ (42,918)	$ (46,566)	$ (50,525)	$ (54,819)	$ (59,479)	$ (423,433)
Less: New Equity Requirement - 2028 Projects	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ (853,420)	$ (853,420)
Less: New Interest Requirement - 2028 Projects	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Less: New Principal Requirement - 2028 Projects	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Net Cash Flow	$ 275,358	$ 248,615	$ (3,051,144)	$ (460,264)	$ (710,121)	$ (694,136)	$ (667,117)	$ (641,708)	$ (122,824)	$ 302,331	$ 350,035	$ 517,995	$ 993,805	$ 1,330,487	$ 2,181,154	$ 2,323,363	$ 2,478,456	$ 3,559,672	$ 4,801,718	$ 6,369,704	$ 6,752,328	$ 7,150,801	$ 8,694,191	$ 42,212,789
Weighted Average Cost of Capital (%)																								11.35%
Net Present Value (NPV)																								$2,882,464
Internal Rate of Return (IRR)																								16.12%

Source: ARROTEC Infrastructure Group, Inc.

Source: AARROTEC for Pemba Data and ICAO for Regional Data

Table 4-4
Nacala Airport Preliminary Financing Plan

	Actual 2006	Forecast 2007	Forecast 2008	Forecast 2009	Forecast 2010	Forecast 2011	Forecast 2012	Forecast 2013	Forecast 2014	Forecast 2015	Forecast 2016	Forecast 2017	Forecast 2018	Forecast 2019	Forecast 2020	Forecast 2021	Forecast 2022	Forecast 2023	Forecast 2024	Forecast 2025	Forecast 2026	Forecast 2027	Forecast 2028	
Development Costs																								
Airside	$ -	$ -	$ -	$ 2,664,622	$ -	$ -	$ -	$ 3,552,831	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 2,664,622	
Landside	$ -	$ -	$ -	$ 1,671,839	$ -	$ -	$ -	$ 2,229,119	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,671,839	
Navaids & Equipment	$ -	$ -	$ -	$ 2,120,600	$ -	$ -	$ -	$ 60,800	$ -	$ -	$ -	$ -	$ 920,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,844,000	
Cargo	$ -	$ -	$ -	$ 60,720	$ -	$ -	$ -	$ 80,960	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 60,720	
Repaving	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 2,043,550	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 2,043,550	
Total Development Costs	$ -	$ -	$ -	$ 6,517,781	$ -	$ -	$ -	$ 5,923,710	$ -	$ -	$ -	$ -	$ 2,963,550	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 8,284,731	
Financing Plan - Phase I																								
Debt (70%)	$ -	$ -	$ -	$ 4,562,447	$ -	$ -	$ -	$ 4,146,597	$ -	$ -	$ -	$ -	$ 2,074,485	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 5,799,312	
Equity (30%)	$ -	$ -	$ -	$ 1,955,334	$ -	$ -	$ -	$ 1,777,113	$ -	$ -	$ -	$ -	$ 889,065	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 2,485,419	
Total Financing Sources - Phase I	$ -	$ -	$ -	$ 6,517,781	$ -	$ -	$ -	$ 5,923,710	$ -	$ -	$ -	$ -	$ 2,963,550	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 8,284,731	
																								2008 Outstanding Balance
Debt Service Requirements - 2009 Projects:																								
Interest Requirement	$ -	$ -	$ -	$ -	$ 387,808	$ 374,072	$ 359,168	$ 342,997	$ 325,452	$ 306,415	$ 285,760	$ 263,350	$ 239,035	$ 212,653	$ 184,028	$ 152,970	$ 119,273	$ 82,711	$ 43,041	$ -	$ -	$ -	$ -	
Principal Requirement	$ -	$ -	$ -	$ -	$ 161,604	$ 175,340	$ 190,244	$ 206,415	$ 223,960	$ 242,997	$ 263,652	$ 286,062	$ 310,377	$ 336,759	$ 365,384	$ 396,442	$ 430,139	$ 466,701	$ 506,370	$ -	$ -	$ -	$ -	
Balance Outstanding	$ -	$ -	$ -	$ 4,562,447	$ 4,400,843	$ 4,225,502	$ 4,035,258	$ 3,828,843	$ 3,604,883	$ 3,361,886	$ 3,098,234	$ 2,812,172	$ 2,501,795	$ 2,165,036	$ 1,799,652	$ 1,403,210	$ 873,071	$ 506,370	$ (0)	$ (0)	$ (0)	$ (0)	$ (0)	$ (0)
Debt Service Requirements - 2013 Projects:																								
Interest Requirement	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 352,461	$ 339,976	$ 326,431	$ 311,734	$ 295,788	$ 278,486	$ 259,714	$ 239,347	$ 217,248	$ 193,270	$ 167,255	$ 139,028	$ 108,402	$ 75,172	$ 39,118	
Principal Requirement	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 146,874	$ 159,359	$ 172,904	$ 187,601	$ 203,547	$ 220,849	$ 239,621	$ 259,989	$ 282,088	$ 306,065	$ 332,081	$ 360,307	$ 390,934	$ 424,163	$ 460,217	
Balance Outstanding	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 4,146,597	$ 3,999,723	$ 3,840,364	$ 3,667,460	$ 3,479,859	$ 3,276,312	$ 3,055,463	$ 2,815,842	$ 2,555,854	$ 2,273,766	$ 1,967,701	$ 1,635,620	$ 1,275,313	$ 884,380	$ 460,217	$ (0)	$ (0)
Debt Service Requirements - 2018 Projects:																								
Interest Requirement	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 176,331	$ 170,085	$ 163,309	$ 155,956	$ 147,979	$ 139,323	$ 129,931	$ 119,742	$ 108,886	$ 176,331	
Principal Requirement	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 73,479	$ 79,725	$ 86,502	$ 93,854	$ 101,832	$ 110,488	$ 119,879	$ 130,069	$ 141,125	$ 139,838	
Balance Outstanding	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 2,074,485	$ 2,001,006	$ 1,921,281	$ 1,834,779	$ 1,740,925	$ 1,639,093	$ 1,528,606	$ 1,408,727	$ 1,278,658	$ 1,137,534	$ 997,697	$ 997,697
Debt Service Requirements - 2028 Projects:																								
Interest Requirement	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	
Principal Requirement	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 5,799,312	$ 5,799,312
Balance Outstanding	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -		$ 6,797,009

Source: ARROTEC Infrastructure Group, Inc.

Table 6-6
Nacala Airport Operating Revenue Projections

Operating Revenues:	Forcast Factors		Actual 2006	Forecast 2007	Forecast 2008	Forecast 2009	Forecast 2010	Forecast 2011	Forecast 2012	Forecast 2013	Forecast 2014	Forecast 2015	Forecast 2016	Forecast 2017	Forecast 2018	Forecast 2019	Forecast 2020	Forecast 2021	Forecast 2022	Forecast 2023	Forecast 2024	Forecast 2025	Forecast 2026	Forecast 2027	Forecast 2028	Average Annual Growth Rate (%)
Aeronautical Revenues:																										
Taxes - Aircraft Landing Fees	Aircraft Operations & Inflation		$ -	$ -	$ -	$ -	$ 65,854	$ 135,781	$ 148,937	$ 162,802	$ 175,099	$ 220,985	$ 237,782	$ 255,982	$ 275,673	$ 294,818	$ 369,685	$ 385,569	$ 423,460	$ 453,564	$ 486,035	$ 611,434	$ 656,117	$ 704,302	$ 756,472	14.53%
Taxes - Aircraft Parking Fees	Aircraft Operations & Inflation		$ -	$ -	$ -	$ -	$ 8,103	$ 16,707	$ 18,325	$ 20,031	$ 21,544	$ 27,190	$ 29,257	$ 31,496	$ 33,919	$ 36,250	$ 45,466	$ 48,671	$ 52,103	$ 55,807	$ 59,802	$ 75,231	$ 80,729	$ 86,658	$ 93,077	14.53%
Taxes - Passenger Fees	Enplaned Passengers & Inflation		$ -	$ -	$ -	$ -	$ 303,859	$ 515,736	$ 574,626	$ 756,630	$ 874,851	$ 1,110,558	$ 1,202,351	$ 1,302,727	$ 1,670,863	$ 1,802,101	$ 2,282,474	$ 2,465,647	$ 2,665,694	$ 3,262,946	$ 3,533,539	$ 4,493,930	$ 4,874,977	$ 5,292,974	$ 6,320,708	18.37%
Taxes - Cargo & Mail Fees	Cargo & Mail Weight & Inflation		$ -	$ -	$ -	$ -	$ 12,012	$ 12,282	$ 13,380	$ 14,477	$ 15,560	$ 19,545	$ 20,832	$ 22,103	$ 23,390	$ 24,678	$ 30,448	$ 31,959	$ 33,469	$ 34,372	$ 36,471	$ 42,795	$ 42,795	$ 42,795	$ 42,795	7.31%
Area Navigation Fees	Aircraft Operations & Inflation		$ -	$ -	$ -	$ -	$ 27,619	$ 56,947	$ 62,465	$ 68,280	$ 73,437	$ 92,683	$ 99,727	$ 107,360	$ 115,619	$ 123,564	$ 155,048	$ 165,904	$ 177,602	$ 190,227	$ 203,846	$ 256,439	$ 275,179	$ 295,388	$ 317,269	14.53%
Usage Fees	Enplaned Passengers, Rates & Inflation		$ -	$ -	$ -	$ -	$ 104,286	$ 176,970	$ 197,178	$ 365,808	$ 422,964	$ 536,921	$ 581,300	$ 629,829	$ 940,742	$ 1,014,633	$ 1,285,096	$ 1,388,227	$ 1,500,859	$ 2,002,569	$ 2,168,640	$ 2,758,061	$ 2,981,922	$ 3,248,459	$ 4,098,914	22.63%
Non-Aeronautical Revenues:																										
Rental Fees	Terminal Space, Rates & Inflation		$ -	$ -	$ -	$ -	$ 397,648	$ 397,648	$ 397,648	$ 312,817	$ 312,817	$ 367,059	$ 367,059	$ 367,059	$ 789,757	$ 789,757	$ 926,701	$ 926,701	$ 926,701	$ 1,195,399	$ 1,195,399	$ 1,402,681	$ 1,402,681	$ 1,402,681	$ 2,672,517	11.16%
Miscellaneous Fees	Aircraft Operations, Rates & Inflation		$ -	$ -	$ -	$ -	$ 3,324	$ 16,789	$ 44,377	$ 47,261	$ 50,333	$ 53,605	$ 57,089	$ 60,800	$ 64,752	$ 68,961	$ 73,444	$ 78,217	$ 83,302	$ 88,716	$ 94,483	$ 100,624	$ 107,165	$ 114,130	$ 121,549	22.13%
Other Revenues	Inflation		$ -	$ -	$ -	$ -	$ 17,337	$ 18,464	$ 19,664	$ 20,942	$ 22,304	$ 23,753	$ 25,297	$ 26,942	$ 28,693	$ 30,558	$ 32,544	$ 34,660	$ 36,913	$ 39,312	$ 41,867	$ 44,588	$ 47,487	$ 50,573	$ 53,861	6.50%
Total Revenues			$ -	$ -	$ -	$ -	$ 940,022	$ 1,347,326	$ 1,476,600	$ 1,769,049	$ 1,968,908	$ 2,452,300	$ 2,620,696	$ 2,804,298	$ 3,943,408	$ 4,185,121	$ 5,200,926	$ 5,535,555	$ 5,900,102	$ 7,322,911	$ 7,820,081	$ 9,785,784	$ 10,479,051	$ 11,237,961	$ 14,477,163	16.41%
Total Revenues/Enplaned Passengers			$ -	$ -	$ -	$ -	$ 28.47	$ 24.04	$ 23.65	$ 27.36	$ 26.34	$ 30.32	$ 29.93	$ 29.56	$ 38.31	$ 37.69	$ 43.40	$ 42.76	$ 42.15	$ 48.35	$ 47.68	$ 55.05	$ 54.34	$ 53.68	$ 63.63	4.57%
Total Passenger Fees/Enplaned Passengers			$ -	$ -	$ -	$ -	$ 9.20	$ 9.20	$ 9.20	$ 11.70	$ 11.70	$ 13.73	$ 13.73	$ 13.73	$ 16.23	$ 16.23	$ 19.05	$ 19.05	$ 19.05	$ 21.55	$ 21.55	$ 25.28	$ 25.28	$ 25.28	$ 27.78	6.33%
Total Usage Fees/Enplaned Passengers			$ -	$ -	$ -	$ -	$ 3.16	$ 3.16	$ 3.16	$ 5.86	$ 5.66	$ 6.64	$ 6.64	$ 6.64	$ 9.14	$ 9.14	$ 10.72	$ 10.72	$ 10.72	$ 13.22	$ 13.22	$ 15.52	$ 15.52	$ 15.52	$ 18.02	10.16%
Total Rental Fees/Rentable Space			$ -	$ -	$ -	$ -	$ 132.55	$ 132.55	$ 132.55	$ 182.55	$ 182.55	$ 214.20	$ 214.20	$ 214.20	$ 264.20	$ 264.20	$ 310.02	$ 310.02	$ 310.02	$ 360.02	$ 360.02	$ 422.44	$ 422.44	$ 422.44	$ 472.44	7.32%
Total Rental Fees-$/Sq.Ft. Equivalent		10.7584	$ -	$ -	$ -	$ -	$ 12.32	$ 12.32	$ 12.32	$ 16.97	$ 16.97	$ 19.91	$ 19.91	$ 19.91	$ 24.56	$ 24.56	$ 28.82	$ 28.82	$ 28.82	$ 33.46	$ 33.46	$ 39.27	$ 39.27	$ 39.27	$ 43.91	7.32%

Source: ARROTEC Infrastructure Group, Inc.

Table 6-7
Nacala Airport Operating Expense Projections

Operating Expenses:	Forcast Factors	Actual 2006	Forecast 2007	Forecast 2008	Forecast 2009	Forecast 2010	Forecast 2011	Forecast 2012	Forecast 2013	Forecast 2014	Forecast 2015	Forecast 2016	Forecast 2017	Forecast 2018	Forecast 2019	Forecast 2020	Forecast 2021	Forecast 2022	Forecast 2023	Forecast 2024	Forecast 2025	Forecast 2026	Forecast 2027	Forecast 2028	Average Annual Growth Rate (%)
Salaries & Benefits	Employees & Inflation	$ -	$ -	$ -	$ -	$ 783,817	$ 834,765	$ 889,024	$ 946,811	$ 1,008,354	$ 1,073,897	$ 1,143,700	$ 1,218,040	$ 1,297,213	$ 1,381,532	$ 1,471,331	$ 1,566,968	$ 1,668,621	$ 1,777,294	$ 1,892,818	$ 2,015,852	$ 2,146,682	$ 2,286,429	$ 2,435,047	6.50%
Supply Costs	Operations & Inflation	$ -	$ -	$ -	$ -	$ 19,283	$ 42,342	$ 49,464	$ 57,583	$ 65,958	$ 75,553	$ 86,579	$ 99,265	$ 113,849	$ 129,582	$ 147,578	$ 168,175	$ 191,734	$ 218,714	$ 249,606	$ 284,997	$ 325,703	$ 372,348	$ 425,924	18.76%
Service Fees	Operations & Inflation	$ -	$ -	$ -	$ -	$ 8,382	$ 18,406	$ 21,502	$ 25,032	$ 28,672	$ 32,843	$ 37,637	$ 43,151	$ 49,491	$ 56,330	$ 64,153	$ 73,107	$ 83,348	$ 95,076	$ 108,505	$ 123,880	$ 141,585	$ 161,862	$ 185,152	18.76%
Financial Costs	Inflation	$ -	$ -	$ -	$ -	$ 1,147	$ 1,221	$ 1,301	$ 1,385	$ 1,475	$ 1,571	$ 1,673	$ 1,782	$ 1,898	$ 2,021	$ 2,152	$ 2,292	$ 2,441	$ 2,600	$ 2,769	$ 2,949	$ 3,141	$ 3,345	$ 3,562	6.50%
Administrative Fee	Operating Revenues	$ -	$ -	$ -	$ -	$ 9,400	$ 13,473	$ 14,766	$ 17,690	$ 19,689	$ 24,523	$ 26,207	$ 28,043	$ 39,434	$ 41,851	$ 52,009	$ 55,356	$ 59,001	$ 73,229	$ 78,201	$ 97,858	$ 104,791	$ 112,380	$ 144,772	16.41%
Total Expenses		$ -	$ -	$ -	$ -	$ 822,028	$ 910,208	$ 976,057	$ 1,048,501	$ 1,124,148	$ 1,208,387	$ 1,295,796	$ 1,390,281	$ 1,501,885	$ 1,611,316	$ 1,737,224	$ 1,865,897	$ 2,005,346	$ 2,166,913	$ 2,331,899	$ 2,525,545	$ 2,722,101	$ 2,936,364	$ 3,194,458	7.83%
Total Expenses/Enplaned Passengers		$ -	$ -	$ -	$ -	$ 24.89	$ 16.24	$ 15.63	$ 16.22	$ 15.04	$ 14.94	$ 14.80	$ 14.65	$ 14.59	$ 14.51	$ 14.50	$ 14.41	$ 14.33	$ 14.31	$ 14.22	$ 14.21	$ 14.12	$ 14.03	$ 14.04	-3.13%

Source: ARROTEC Infrastructure Group, Inc.

Table 6-8
Nacala Airport Cash Flow Projections

Cash Flow:	Actual 2006	Forecast 2007	Forecast 2008	Forecast 2009	Forecast 2010	Forecast 2011	Forecast 2012	Forecast 2013	Forecast 2014	Forecast 2015	Forecast 2016	Forecast 2017	Forecast 2018	Forecast 2019	Forecast 2020	Forecast 2021	Forecast 2022	Forecast 2023	Forecast 2024	Forecast 2025	Forecast 2026	Forecast 2027	Forecast 2028	Total 2006-2028
From Operations:																								
Operating Revenues	$ -	$ -	$ -	$ -	$ 940,022	$ 1,347,326	$ 1,476,600	$ 1,769,049	$ 1,968,908	$ 2,452,300	$ 2,620,696	$ 2,804,298	$ 3,943,408	$ 4,185,121	$ 5,200,926	$ 5,535,555	$ 5,900,102	$ 7,322,911	$ 7,820,081	$ 9,785,784	$ 10,479,051	$ 11,237,961	$ 14,477,163	$ 101,267,261
Less: Operating Expenses	$ -	$ -	$ -	$ -	$ (822,028)	$ (910,208)	$ (976,057)	$ (1,048,501)	$ (1,124,148)	$ (1,208,387)	$ (1,295,796)	$ (1,390,281)	$ (1,501,885)	$ (1,611,316)	$ (1,737,224)	$ (1,865,897)	$ (2,005,346)	$ (2,166,913)	$ (2,331,899)	$ (2,525,545)	$ (2,722,101)	$ (2,936,364)	$ (3,194,458)	$ (33,374,353)
From Development:																								
Less: Existing Debt Service - Principal	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ (1,955,334)
Less: New Equity Requirement - 2009 Projects	$ -	$ -	$ -	$ (1,955,334)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ (3,678,732)
Less: New Interest Requirement - 2009 Projects	$ -	$ -	$ -	$ -	$ (387,808)	$ (374,072)	$ (359,168)	$ (342,997)	$ (325,452)	$ (306,415)	$ (285,760)	$ (263,350)	$ (239,035)	$ (212,653)	$ (184,028)	$ (152,970)	$ (119,273)	$ (82,711)	$ (43,041)	$ -	$ -	$ -	$ -	$ (4,562,447)
Less: New Principal Requirement - 2009 Projects	$ -	$ -	$ -	$ -	$ (161,604)	$ (175,340)	$ (190,244)	$ (206,415)	$ (223,960)	$ (242,997)	$ (263,652)	$ (286,062)	$ (310,377)	$ (336,759)	$ (365,384)	$ (396,442)	$ (430,139)	$ (466,701)	$ (506,370)	$ -	$ -	$ -	$ -	$ (5,151,597)
Less: New Equity Requirement - 2013 Projects	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ (1,777,113)	$ -	$ -	$ -	$ -	$ (889,065)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ (3,343,430)
Less: New Interest Requirement - 2013 Projects	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ (352,461)	$ (339,976)	$ (326,431)	$ (311,734)	$ (295,788)	$ (278,486)	$ (259,714)	$ (239,347)	$ (217,248)	$ (193,270)	$ (167,255)	$ (139,028)	$ (108,402)	$ (75,172)	$ (39,118)	$ (4,146,597)
Less: New Principal Requirement - 2013 Projects	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ (146,874)	$ (159,359)	$ (172,904)	$ (187,601)	$ (203,547)	$ (220,849)	$ (239,621)	$ (259,989)	$ (282,088)	$ (306,065)	$ (332,081)	$ (360,307)	$ (390,934)	$ (424,163)	$ (460,217)	$ 889,065
Less: New Equity Requirement - 2018 Projects	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ (1,487,674)
Less: New Interest Requirement - 2018 Projects	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ (176,331)	$ (170,085)	$ (163,309)	$ (155,956)	$ (147,979)	$ (139,323)	$ (129,931)	$ (119,742)	$ (108,886)	$ (176,331)	$ (1,078,788)
Less: New Principal Requirement - 2018 Projects	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ (73,479)	$ (79,725)	$ (86,502)	$ (93,854)	$ (101,832)	$ (110,488)	$ (119,879)	$ (130,069)	$ (141,125)	$ (139,838)	$ 2,485,419
Less: New Equity Requirement - 2028 Projects	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Less: New Interest Requirement - 2028 Projects	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Less: New Principal Requirement - 2028 Projects	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 5,799,312	$ 5,799,312
Net Cash Flow	$ -	$ -	$ -	$ (1,955,334)	$ (431,418)	$ (112,293)	$ (48,868)	$ (1,605,977)	$ (203,987)	$ 195,166	$ 276,153	$ 365,270	$ 503,712	$ 1,525,057	$ 2,414,955	$ 2,620,910	$ 2,646,009	$ 4,107,250	$ 4,439,435	$ 6,760,903	$ 7,257,615	$ 7,802,262	$ 8,287,951	$ 45,054,771
Weighted Average Cost of Capital (%)																								11.35%
Net Present Value (NPV)																								$5,396,018
Internal Rate of Return (IRR)																								20.09%

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SECTION 5: LEGAL FRAMEWORK FOR TRANSFER OF NACALA AIRPORT

5.1 Review of Existing Laws

There are two laws of primary importance to the proposed transfer of Nacala from a military base to a civilian facility[1]:

1. The Land Law, Law No. 19/97 of 1 October 1997[2]; and its associated Regulations:

   a) The Land Law Regulations; Decree No. 66/98 of 8 December 1998[3];

   b) Urban Land Regulations[4];

2. Decree 3/98 of 10 February 1998 transitioning the former state company controlling civil aviation into a public company, Aeroportos de Moçambique, E. P. (ADM). This decree sets forth the rights, duties and powers of the above-mentioned public company.

5.1.1 Summary of the Laws

The starting point for any discussion of land in Mozambique is that all land in Mozambique belongs to the State[5]. Individuals and entities may obtain the "Right of Use and Benefit of the Land' for a period of 50 years, which is then renewable for an additional 50 years. At the end of the second 50-year period, a new application must be filed, and any fixed assets on the land revert to the state on the expiration of the final term.

The specific portion of the 1997 Land Law that speaks to the issue at hand is found in Articles 7 and 8. These two articles create "Total Protection" and "Partial Protection" zones, where no right of use and benefit may be granted, but licenses for economic activities may be obtained. Airport facilities are listed specifically in Article 8(i) as being

[1] The same issues are presented in transitioning the current military base to a shared facility. Currently three airiports in Mozambique have a civilian side and a military side, to wit: Maputo, Beira and Nampula.
[2] Laws are numbered in series each year as they pass. Therefore, the Land Law is the 19th piece of legislation passed by the full parliament in 1997 and the passage date was October 1, 1997.
[3] Decrees are issued by the Council of Ministers. They are also numbered in series as they are passed each year, followed by the date of passage.
[4] These Regulations were approved by the Council of Ministers in late 2006, but have not yet been formally published. This analysis relies on an interpretative report produced by USAID entitled Land Use Rights for Commercial Activities in Mozambique, which had access to the 2006 Decree.
[5] Constitution Article 46(1) ; The Land Law, Article 3.

in a Partial Protection Zone and Article 7 names military or defense properties as Total Protection Zones.

These designations may only be changed by an act of the Council of Ministers. Article 22(3)(b) allows the Council of Ministers to create, modify or extinguish protected zones, and thus has the power to modify the existing Total Protection zone to a Partial Protection zone for civilian use. Additionally, the power is included in this Article for the Council of Ministers to increase the land area of the airport if, in extending the runway or in creating a shared facility[6], additional land is required. If some of the land that is required for expansion is already occupied[7], Article 18(1) (b) gives the government the right of eminent domain to acquire the land use rights of others for the public benefit.

The Land Law has established the governmental status of the land, but it has not answered the question: who holds the rights to use and develop the land? Decree 3/98 of 10 February 1998 converted the former state agency, Empresa Nacional de Aeroportos de Moçambique, E.E. (the E.E. designating it as a State owned entity) to Aeroportos de Moçambique, E.P., (ADM) which is a public company[8].

Article 4 of Decree 3/98 establishes that all airport facilities previously held by the State Entity are now owned by the Public Company and even ratifies actions taken by ADM, prior to its formal creation by decree. There can be no question that the existing facility at Pemba is property whose use and benefit is directed and title is established in ADM.

Attached to Decree 3/98 and annexed thereto is the corporate charter created by the Council of Ministers that sets forth the operational structure and limits of authority held by ADM. Article 3 of the charter gives ADM the exclusive right to establish airports and to operate, maintain and improve airport facilities, noting in the law that such operations should be in compliance with International standards. Article 7 of the Charter provides a list of the powers of the Board of Directors of ADM. At subsection (s) is the power to approve the acquisition of new properties and to make decisions regarding the manner of financing.

An interesting note regarding the ability to finance the airports is Article 20 regarding the capitalization of ADM. In subsection (3) ADM is specifically limited from alienating, mortgaging or otherwise encumbering facilities on their properties.

[6] The drafter of this section of the present report inquired of several government sources regarding the existence of laws, decrees or even protocols providing guidelines for airports where the Military and Civilians use the same runway, navigational, and ATC facilities. In each instance the reply was that this arrangment has existed since Colonial days and no writing exists. Currently there appear to be few problems with the arrangement.

[7] 'Occupied' as used here is a word of art, meaning the right of use and benefit has been acquired by a national individual's good faith use of the land for at least ten years. Equally, the land could be occupied by one who has filed a plan for title.

[8] Whilel ADM is a public company with shareholders, and led by its board of directors, the 100% shareholder is the Government of Mozambique. This structure allows the state owned company to follow accepted business practices without being limited by State Bureaucracy and rules required by direct government agencies.

5.1.2 Application to ADM

According to several ADM sources, the lands that form both the Pemba Airport and the Nacala military base have been used as such since colonial days. ADM has recently hired surveyors to outline and sketch the actual dimensions of each of its airports and has filed these for approval and certification by the local Cadastral Service in each province where an airport is located[9]. Inasmuch as Pemba airport was formerly government property and was transferred to ADM by Decree 3/98 of 10 February, and it has continuously been operated as an airport, it is unquestionably land within a Partially Protected Zone. By being in a Partially Protected Zone it is land on which no entity or individual may seek a Title.

Equally, it is quite certain that Nacala is a government owned military base, and thus within a Total Protection Zone. If the Council of Ministers chooses to convert all or a portion of the land and facilities at Nacala to a civilian airport it can do so by Decreeing the change in status, pursuant to Article 22(3)(b) of the Land Law.

It is also significant that the government has published an extensive document outlining its road map for development, entitled Agenda 2025. In this document, the development of Nacala as an international civilian airport is listed specifically as a goal to be achieved prior to the year 2025. While the Agenda is aspirational, rather than binding law, it appears that there will be little opposition to the transfer of all or part of Nacala to a civilian facility on the part of the Council of Ministers.

5.2 Recommendations to Facilitate Transfer Process

5.2.1 Legal/Financing Issues

The first question in financing is to isolate the owner. As noted above, it seems clear that the airports are owned (or at least the exclusive right to manage is held) by ADM. This is indicated by both the Land Law wherein all airports are noted as Partial Protection Zones, and by Decree 3/98, which conferred all existing airport property to ADM as well as the exclusive right to manage and operate all airports. However, to determine the ability to finance by conventional means, a brief review of titles and the right to mortgage is provided.

Any person (including foreigners and corporate entities) may seek the right of use and benefit. The gaining of this right of use and benefit is accomplished in various ways depending on the use to be made and the status of the applicant. These distinctions seem unnecessary for this report inasmuch as the locations of Pemba and Nacala have

[9] ADM reports this is a slow process and is dependent on the vagaries of each local Cadastre office in the province of the airports. ADM reports only one airport has been certified and recorded. Pemba has been surveyed and sketched but not yet approved. This process will be required if the Council of Minister's approves the transfer of all or a portion of Nacala to ADM.

been an airport and a military base, respectively, since the colonial period and are therefore currently characterized by law as a partially protected zone in the case of Pemba and a total protection zone in the case of Nacala.

The rights of use and benefit of land (which may be registered and will hereafter be referred to as "Title") is divided into two categories: Rural Tenements and Urban Tenements[10]. An interesting insight, however is that the distinction as written into the 1998 Regulations has nothing to do with where the land is located (within urban areas or rural areas), but makes its distinction on whether the true value of the land is in the improvements (a small plot with a home built on it) or in the land where improvements are only incidental to its value (farm land with a shed built on it). The 2006 Decree clarifies this at least a bit by providing in Article 1(10) that any land, regardless of use, within an "urbanized area" is an Urban Tenement. Thus any right of use in an urbanized area is now an urban tenement, but a hotel in a game preserve in a rural area would still qualify as an urban tenement, despite the fact it is located in a rural area.

This distinction is more than academic. The Land Law makes a distinction in the ability to sell or mortgage the immoveable assets on a tenement depending on its classification. With an urban tenement, the right to use the land transfers automatically, and does not need government consent, with the sale of the immoveable assets. The transfer need only be recorded on the Title. With a rural tenement, any right to use the land must be authorized by the "competent state entity" prior to the transfer.

The Constitution in Article 46(2) states "land may not be sold, mortgaged or otherwise encumbered or alienated." The Land Law in Article 16(5) states:

> "The titleholder of the right of land use and benefit may mortgage the immovable assets and improvements which he/she has duly been authorized to make on the land or which he/she has legally acquired a right of ownership over."

Thus when one reads the distinctions in the types of tenements and this right to mortgage immovable assets, it is clear that one can mortgage a structure on an urban tenement and if a foreclosure is necessary, the lender will gain not only the rights in the structure, but also the right of use and benefit of the land for the remainder of the titleholder's rights.

While an airport that derives its economic benefit from the land it occupies is clearly an urban tenement[11] pursuant to this law, conventional financing is still not feasible since as a protected zone, no right to use and benefit can be granted[12]. Additionally, Decree 3/98 in the annexed charter in Article 20(3) prohibits the mortgaging of airport property. Additionally, Decree 3/98 provides ADM with the *exclusive* right to operate airports.

[10] Land Law Regulations, Decree 66/98 of 8 December, Article 1(4) and (5).
[11] In the case of Pemba, the airport is also located within an urbanized area.
[12] The Land Law, Article 9.

Therefore, for numerous reasons a foreclosure on airport property is simply not feasible. The financing of any airport project in Mozambique will either need to be by Build-Operate-Turnover, done under a grant of specific authority (and under the supervision) from ADM, Development Bank soft loans, or guaranteed by a Sovereign State Guarantee.

5.2.2 Legal/Environmental Issues

The law of primary importance to the proposed airport expansions of either Nacala or Pemba is the Environmental Protection Law; Law No. 20/97 of 1 October, and the Regulations on the Environmental impact Assessment Process Decree No. 45/2004 of 24 August[13]

The Environmental Protection Law creates categories for all projects to be undertaken in Mozambique. Once the category of the project is determined, the level of environmental impact assessment that is required can be established. Decree 45/2004 provides a form "Preliminary Environmental Information Sheet" that should be filled out and submitted to the Ministry for the Coordination of the Environmental Affairs (MICOA) prior to the beginning of a project[14]. [15]. The AAROTEC Team is conducting an Environmental Study according to the Multi-Lateral Funding Institutions, which is more detailed than the Mozambique Environmental Law Decree 45/2004.

The three Categories[16] into which all projects are divides are (A) requiring a full Environmental Impact Report, (B) requiring a Simplified Environmental Report and (C) requiring no report, but only adherence to "guidelines of good environmental management." By Decree, if a project is Category C and thus exempt from pre-project report filing, MICOA must notify the tenderer within 5 working days of the submission of its Preliminary Environmental Information Sheet[17].

Appendix 1 to Decree 45/2004 sets out the activities and specific types of land areas that will likely cause a project to be classified as Category A. There are two items that speaks most directly to the proposed airport expansions/renovations in Appendix 1(1). These are subsections (a) and (k) which state:

(a) All activities implying population resettlement, and;

[13] These Regulations passed in late 2004 replaced Decree 76/98 of 29 December.

[14] As noted in the footnote above this is the second set of Environmental regulations. The first issued in 1998 are replaced by these more thorough regulations. However, the drafter of this report believes that new regulations will be forthcoming again within the next few years that will hopefully close a few more areas where there is simply no regulation at this time.

[15] As noted in the footnote above this is the second set of Environmental regulations. The first issued in 1998 are replaced by these more thorough regulations. However, the drafter of this report believes that new regulations will be forthcoming again within the next few years that will hopefully close a few more areas where there is simply no regulation at this time.

[16] Decree 45/2004, Article 3.

[17] Decree 45/2004, Artilcel 7(4).

(k) Airports, aerodromes and heliports with a runway of length equal or greater than 1,800 meters;

Both of the airports under consideration already have runways of at least 1800 meters, and to extend Pemba will almost certainly cause the relocation of people living on the border with the current airport facility. This scenario creates one of the issues addressed in the footnotes; there is no regulation that answers the question: What Category is a project to upgrading and redevelop an airport that has an existing runway that has already exceeded the 1800 meters threshold. The closest statement in the law to this scenario is in Appendix III, which provides the activities that qualify for a Category C exemption. In subparagraph (h) it states: "installation of equipment within already existing rail-port areas." Therefore, assuming that an airport is a qualifying "port" much of the anticipated project would be exempt from any environmental report.

It seems clear that by custom and usage as it has developed in Mozambique that these projects both qualify as exempted Category C projects. When ADM drafted a letter to MICAO introducing this feasibility study and seeking their cooperation in meeting with the team that would be in country to do research, within a few days MICOA drafted and exemption certificate telling ADM that both Pemba and Nacala projects are exempt from filing any environmental report. This exemption was issued without the required filing of the Preliminary Environmental Information Sheet, which would specify the totality of the project, including the possible need to acquire additional land and relocate people.

In conclusion to this section, it seems clear that the law should be followed and the required information sheet should be submitted for the selected project. Whether it remains exempted will only be seen after careful adherence to the existing law.

5.2.3 Civilian/Military Cooperation

In addition to the above-mentioned legal texts, the Ministry of Transport and Telecommunications and the Ministry of National Defense signed a Memorandum of Understanding dated August 21, 2006. This agreement stipulates *inter alia* that the two ministries will cooperate and coordinate their activities in creating common fields of activity and that they will, through their respective structures; establish programs aimed at the efficient management of the actions devolving from the above-mentioned Memorandum.

In particular, the Memorandum states that the two ministries will promote institutional partnership in the maritime, aviation, telecommunications, infrastructure and road fields. In the field of Aviation the parties, in partnership, undertake to:

a) Establish a Civil/Military Coordination Commission for the control of the national airspace;

b) Mobilize resources for the acquisitions of equipment for the control of the national airspace;

c) Cooperate in the training of aeronautical personnel, in particular pilots, air traffic controllers, aeronautical mechanics, flight operations technicians, *inter alia* and establish a system of respective equivalencies;

d) Coordinate activities of search and rescue using the equipment of both parties, and;

e) Establish standards and additional mechanisms for the management and control of the national airspace.

In the field of Infrastructure, the parties, in partnership, undertake *inter alia* to coordinate the use of part of any installations of the [military] Air Bases and Aerodromes for civilian purposes. For the purposes of the execution of this Memorandum with respect to infrastructure, the Ministry of Transport and Telecommunications designates as its representative the National Directorate of Economy and Investments.

Although this Memorandum provides a general framework for an eventual agreement regarding the transfer of part of the Nacala Air Base to civilian administration as a commercial airport, it does not mention any specific mechanism for such a transfer. This would require a more specific agreement between the two ministries and, as stated previously, a duly adopted decree of the Cabinet at a minimum.

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SECTION 6: EVALUATION AND SELECTION OF ALTERNATIVES

6.1 Comparative Analysis

The following paragraphs discuss the comparison of the two options for the development of airport facilities in the Northern Coastal region of Mozambique as defined in the Terms of Reference of the present study:

1) the expansion of Pemba airport, including the extension of the runway and the provision of additional taxiway, apron and terminal facilities, in order to be able to accommodate long-haul international flights

2) the conversion of the Nacala military airfield to civilian use, including the upgrading of the existing runway, taxiway and apron facilities and the provision of air navigation, air traffic control and passenger terminal facilities, in order to be able to accommodate commercial aviation, including long-haul international flights

6.1.1 Technical Analysis

Our technical analysis indicates that either course of action is technically feasible. This being said, the development of Nacala airfield as a civilian airport equipped to handle long-haul commercial flights (Option B) will present fewer technical challenges, due to the length of the existing runway (2500 m) and the extensive flat land area on which the present facilities are located. Very simply stated, Nacala can be developed and expanded for the foreseeable future with virtually no technical constraints.

The same cannot be said for the expansion of Pemba airport to handle long-haul international flights (Option A), which would require a massive program of earthworks and disruption of the local environment in order to provide for the required extension of the runway. Very simply stated, the inherent site constraints of Pemba airport mean that it can only be expanded at great expense and with limited long-term benefit

6.1.2 Legal Analysis

From the legal perspective, either project can be accomplished with minor legal intervention. The method for transferring land to ADM from the Military is set forth clearly in the Land Law, and requires a decree or resolution from the Council of Minister.

The method for acquiring additional land around the Pemba airport, if it is selected, is also set forth quite clearly in the eminent domain section of the land law. Once either parcel is held by ADM, it has the legal authority to develop, create and supervise airport activities as its board of directors designate, pursuant to its only enabling Decree.

The only serious legal obstacle facing either airport is the filing of the necessary Preliminary Environmental Information Sheet and seeking either a new categorization of the project or an affirmation that it may proceed as an exempt project.

6.1.3 Financial Analysis

The financial analysis presented in the Section 4 indicates that both options (Pemba and Nacala) for the upgrading of airports in the Northern Coastal area to international status would be justified on basis of the net present value (NPV) of the required investments. In both cases, the NPVs are positive, meaning that the Internal Rate of Return (IRR) would exceed the Weighted Average Cost of Capital (WACC). More specifically, the IRR for Option A (Pemba) was calculated to be 15.86% whereas the IRR for Option B (Nacala) was calculated to be 19.91%), both of which are in excess of the required WACC of 11.35%. This being said, the upgrading of Nacala to international status would be the preferable choice; since the calculated IRR (19.91%) exceeds the ADM target investment rate (18%), as well as the WAAC (11.35%).

6.2 Effects on Vilankulos and Other Airports

It was thought that the proposed investments in improved airport facilities at Pemba and/or Nacala might have an impact on the expected levels of traffic at other airports in the ADM system. Although the Terms of Reference of the present study identified Vilankulos airport as being susceptible to the possible diversion of air traffic to airports in the North of the country, we have concluded that the airport most likely to feel the effects of expanded facilities at Pemba or Nacala would instead be Nampula. After having analyzed the traffic patterns and discussed with economic agencies and tourism operators, it became obvious that a portion of the air traffic at Nampula airport has its ultimate origin/destination in the Nacala sub-region (Nacala City and its associated tourism destinations).

6.3 Recommendations

Considering the long-term costs and benefits of the two options, AAROTEC recommends that priority be given to the development of Nacala as an international airport, since construction of the required infrastructure to accommodate long-range flights and future expansion is more feasible at this site. At the same time, since a limited extension of the runway, together with minor upgrades and expansion of the passenger terminal at Pemba appear to be economical in the short term, AAROTEC recommends a strategy which allows both areas to enjoy improved air service.

In terms of the implementation of a phased development strategy, Nacala should be designated immediately as a general aviation airport while looking toward eventually

upgrading to a commercial airport. Nacala can be designated as a general aviation airport with hardly any investment cost and then to charter service and eventually to a bare bones international airport as passenger traffic to the region justifies the action.

This being said, after having studied the available documentation, inspected the airport existing airport facilities and performed our own independent analysis the AAROTEC Team has come to the conclusion the development of the Pemba and Nacala airports should not be seen as a simplistic "either/or" choice. In fact, both airports require upgrading in order to be able to serve their respective regions effectively and play the role of catalyst in furthering the stated economic and social development objectives, policies and strategies of the Government. The appropriate development of both airports is especially critical to the achievement of Government's Strategic Tourism Development Plan. We have therefore concluded that the central issue is rather a question of determining the relative priorities, timing and level of development at the two sites.

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SECTION 7: DEMAND/CAPACITY ANALYSIS AND FACILITY REQUIREMENTS

7.1 Demand/Capacity Analysis

Introduction

This section describes the demand/capacity analysis which was used as a basis for determining the requirements for development of the proposed international airport facilities at Pemba and Nacala according to the most likely growth scenario. The criteria for airport development were based on accepted ICAO, FAA and IATA standards and guidelines, local constraints and the expressed needs of the users of the facilities. This section defines the investment needs and the new infrastructure which will be required to provide for the modernization and the continued development of the airports at Nacala and Pemba to international status.

Much of the proceeding material includes excerpts from various studies commissioned by ADM and other Mozambican authorities. These include the Business Prospectus for the Nacala Development Corridor Airport Group by the Louis Berger Group, Inc. dated May 2004, the Project for Expansion of Pemba Aerodrome by BKS Global Ltd., dated March 2007 and the Pemba Upgrade, Conceptual Design Report; Airside Development by BKS Global Ltd., dated April 2007. This material was heavily relied upon for base data; however since our mission is to provide a feasible plan for an international airport at either Pemba or Nacala the resulting decisions are quite different. This is not to say that any of the previous studies are incorrect. Rather, the objective is different and requires different answers. The AAROTEC Team is guided by realistic forecast and cash flow analysis to reach the conclusions drawn from the data.

Approach and Methodology

To ensure that the airports will be able to accommodate the aviation demands in the future, it is necessary to evaluate each Airport's capacity and to identify their compliance with international safety and security standards and the adequacy of the airports' existing facilities, in accordance with the operational category of each airport.

A Demand/Capacity Analysis of the Airports' major existing facilities (infrastructure) was conducted to identify existing deficiencies that would serve as the basis for calculations for future requirements. The analysis was based on a combination of four considerations:

1. Visual inspection of facilities
2. Interviews with airport management and staff
3. Application of ICAO and IATA international standards and recommendations
4. Results of previous studies

Balance is needed in the planning process. The airfield, terminal building, cargo building, rescue and fire fighting facility, air traffic control tower, aircraft ground servicing equipment, airfield maintenance, ground access and other facilities should be located to provide planned space for future expansion which will be compatible with other facilities. This will ensure that all the facilities are designed so that each one is properly sized to fulfill its required function throughout the planned phases of development. For example, a long runway to handle high passenger capacity, wide body aircraft would be useless if terminal facilities, auto parking and other land-based transportation facilities, apron parking, and fuel storage and dispensing facilities were inadequate to serve either the traveling public or the serving airline equipment.

7.1.1 Airside Capacity Considerations and Taxiway Requirements

Runway and Taxiway System

Under ICAO guidelines, the airport is assigned an aerodrome reference code. The first element of the code is a number, 1 through 4, based on the airplane reference field length required for the aircraft. This runway length is the minimum field length required for an aircraft to take off at maximum certificated takeoff weight at sea level, standard atmospheric conditions, no wind, and zero runway slope. This length is equivalent to the balanced field length or takeoff distance as determined by the aircraft manufacturer. The second element of the ICAO code is the aerodrome reference letter, A through E, based on an aircraft's wingspan and the span between the outside wheels of the main landing gear.

Aircraft weight is another key consideration in overall airport planning. The most obvious effect of aircraft weight is in pavement design and other structural components. Aircraft weight is also a major factor related to runway length requirements. A higher gross takeoff weight, thus, requires a longer runway. With takeoff thrust being constant, a heavy aircraft will accelerate slower than a lighter aircraft and consequently use more runway length for takeoff. With commercial transport aircraft, aircraft weight is a critical factor and can vary widely based on loading configuration and haul length. Also, an aircraft may have a choice of different engines which will have an effect on the performance of that aircraft. An aircraft can carry 50 percent of its maximum payload with additional fuel for a much longer distance. On the other hand, that same aircraft can be loaded to 90 percent or more of its maximum payload with the result that the maximum flight distance will be much shorter. Both stage length and load factor must be considered when determining runway length requirements. The purpose of the upgrade is to serve flights to and from European cities. The distance to several likely destinations is included in the following table.

Table 7.1 Distance to Likely Mozambique Tourism Markets

From Pemba to:	Nautical miles	Statute miles	Kilometers
Paris, France	4220	4856	7815
Frankfort, Germany	4130	4753	7649
Madrid, Spain	4030	4638	7464

Lisbon, Portugal	3980	4580	7371
Rome, Italy	2620	3015	4852
Abu Dhabi, UAE	2380	2739	4408
Doha, Qatar	2375	2733	4399
From Nacala to:			
Paris, France	4300	4948	7964
Frankfort, Germany	4220	4856	7815
Madrid, Spain	4110	4730	7612
Lisbon, Portugal	4060	4672	7519
Rome, Italy	3710	4269	6871
Abu Dhabi, UAE	2460	2831	4556
Doha, Qatar	2455	2825	4547

Table 7.2 shows the various transport jet aircraft that are expected to serve the airports during the period represented in the planning along with their airport and ICAO aerodrome reference codes. Based on the fleet mix forecasts, the ICAO aerodrome reference code that will be used as the basis for airport planning recommendations for the new selected International Airport will be 4D (runway of 1,800 m or more and used by aircraft with wingspans of 36 to 52 m). The occasional use of the airport by larger aircraft, such as the B-747-200, is not expected to warrant using the higher standards for several years until the tourism infrastructure in the target areas (lodging accommodations, attractions, services, etc.) is adequate to handle the number of passengers.

Runway Characteristics and Length Requirements

Runway length is a function of several factors, all of which must be considered carefully to meet the needs of the airport and its users. Field elevation, temperature, longitudinal slope (gradient), orientation, topography, aircraft type, and ceiling and visibility conditions are just some of the factors that need to be analyzed before a final runway orientation and length can be determined.

As a commercial service airport, the overriding need that must be met will be the requirements of the airlines that will be using it. The runway length, width and weight bearing capacity will be determined by the most demanding aircraft that will be reasonably expected to use the airport in the future. It is important to keep in mind that the needs of the airport will change in time due to conditions that have not been forecast or that differ from expectations.

Based on the aircraft that are expected to use the new international airport facilities in the short to medium term, the runway should be planned to accommodate aircraft with an ICAO aerodrome reference code of 4D. Some larger aircraft that require an airport with an ICAO aerodrome reference code of 4E are likely to use the airport as well, but this activity is expected to constitute less than 10% of the operations even in the long term. With such few operations, it is recommended that the airfield pavements be designed to

accommodate aircraft up to the A310, since this represents an appropriate size corresponding to the likely capacity of the tourism infrastructure in the Pemba and Nacala regions for the immediate future. For long-term planning purposes and to reserve sufficient space for ultimate development, the airport geometry and zoning should be able to accommodate larger aircraft with an ICAO aerodrome reference code of 4E. This can best be accomplished by acquiring or reserving sufficient land now for the expected future expansion and designing the airfield geometry with this in mind.

Table 7.2 Aircraft Performance Characteristics

Maximum performance at standard conditions at sea level

Aircraft	Runway length m	Range (nm)	Passengers	Maximum takeoff weight (kg)
Regional Flights				
A300-300	1,800	4,000	295	210,000
A300-600	2,316	2,800-4,000	247-375	165,000
A310-300	2,308	4,700	200-280	149,997
A320-200	1,715	3,050-5,700	138-179	71,998
A321-100/200	2,400	3,000-5,600	220	82,200
B737-300	1,920	2,500-3,500	128-149	56,472
B737-400	2,224	2,250-2,800	146-189	62,822
B737-500	1,554	2,700-3,500	108-149	52,390
B737-600°	1,800-2,480	3,750	108-132	66,000
B737-700	2,200	3,365-6,200	128-149	69,626
B737-800"	2,400-2,750	2,200-3,060	162-189	79,010
B737-900ER	2,500-2,800	2,400-3,200	220	85,000
B787-3	2,800	2,500-3,050	290-330	165,100
International Flights				
A330-200	1,800	4,500	253	208,000
A340-200/300	2,316	3,350-6,800	262-375	253,511
A340-500	3,250	9,000	313-384	380,000
B747SP	2,300	5,750	299	320,000
B747-100	3,100	4,800	452-485	340,000
B747-200	3,200	5,400	452-485	365,000
B747-300	2,500	5,600	565-608	377,000
B747-400	3,300	7,260	400-524	396,890
747-400ER	3,200-4,750	7,670	400-524	412,769
B767-200	1,828	4,000	216-255	142,880
B767-200ER	2,800	6,600	216-255	179,169
B767-300	2,438	4,000	261-290	156,488
B767-300ER	2,650	6,105	218-269	181,437
B767-400ER	2,750	5,645	304-245	204,116
B777-200	2,450	5,955	305-440	247,300
B777-200LR	3,400	8,000	279-301	347,818
B777-300	3,400	7,730	368-550	299,369
B777-300ER	3,200	9,420	301-368	351,533
B787-8	2,800	7,650-8,200	210-250	219,540
B787-9	2,800	8,000-8,500	250-290	244,940

For pavement design purposes, the critical aircraft is the A310; its large size and weight contribute the most stress to the pavement.

Table 7.3 Aircraft Characteristics for Reduced Take-off Load on 2,500 m Runway

Aircraft	Reduced takeoff weight		Adjusted Range	Runway length	European Destinations	Wing Span	Main Track	Aircraft Category
International Flights	%							
330-200	-----	N/R	-----	-----	YES	60.304m	10.684m	E
A340-200/300	-----	N/R	-----	-----	YES	60.304m	10.68m	E
A340-500	13.2	330,000	8,000	2,500	YES	63.44m	10.68m	E
B747SP	-----	N/R	-----	-----	YES	59.64m	11.00m	E
B747-100	11.8	300,000	4,400	2,500	YES	59.64m	11.00m	E
B747-200	6.9	340,000	4,400	2,500	YES	59.64m	11.00m	E
B747-300	-----	N/R	-----	-----	YES	59.64m	11.00m	E
B747-400	13.1	345,000	4,500	2,500	YES	64.92m	11.00m	E
747-400ER	11.9	364,000	5,300	2,500	YES	64.92m	11.00m	E
B767-200	-----	N/R	-----	-----	YES	47.57m	9.30m	D
B767-200ER	5.1	170,000	6,000	2,500	YES	47.57m	9.30m	D
B767-300	-----	N/R	-----	-----	YES	47.57m	9.3m	D
B767-300ER	5.2	172,000	5,000	2,500	YES	47.57m	9.30m	D
B767-400ER	9.4.	185,000	4,800	2,500	YES	51.92m	9.30m	E
B777-200	-----	N/R	-----	-----	YES	60.93m	10.97m	E
B777-200LR	13.8	300,000	6,300	2,500	YES	64.80m	10.97m	E
B777-300	14.8	255,000	3,300	2,500	NO	60.93m	10.97m	E
B777-300ER	10.4	315,000	5,000	2,500	YES	64.80m	10.97m	E
B787-8	8.9	200,000	6,500	2,500	YES	60.12m	9.80m	E
B787-9	8.1	225,000	7,000	2,500	YES	62.09M	N/A	E

Source of Date is from Airbus and Boeing arranged by AAROTEC (2007)
N/A: not available at time of compilations;
N/R: not required
At sea level, standard day, no wind, level runway
All data is approximate,
Consult "Operating Manuel" for the particular aircraft.
Unreleased until this date. Data shown are preliminary.

Aircraft are becoming lighter, more fuel efficient and more powerful, consequently are able to take off on a shorter runway and fly to farther destinations with a heaver payload. Table 7.4 gives some examples of modern aircraft. Table 7.5 shows the aircraft that can land and take off on a 2,500 meter runway with about a ten percent payload penalty and reduced fuel. However this is at standard conditions. Average requirements for the noted airport reference temperature (ART) require a reduction of about ten percent in payload and flight range. Hot summer conditions require an additional ten percent reduction in payload and flight range. The table 7.2 shows the runway length requirements for several aircraft. For the destinations shown, a runway length of 2,800 m appears reasonable. For the ultimate development, if larger aircraft were to use the facility, a longer runway would be needed. A length of 3,100 m would be adequate to serve more than 90 percent of the aircraft that might use the airport.

The runway width required for this classification of airport is 45 m with 7.5 m wide shoulders. The shoulders should be paved in order to provide an area for occasional

passage by aircraft inadvertently leaving the main paved runway (or taxiway) area. Airport service vehicles also may use the shoulders rather than the actual runway or taxiway.

The runway landing strip is 300 m wide, 150 m each side of centerline and extends 60 m beyond the threshold of the runway. This area must be clear of any obstacles. The required graded portion of this strip is 150 m wide, 75 m (37.5m beyond the paved area) each side of the runway centerline for the first 150 m of each runway end. The graded portion then transitions in another 150 m longitudinally to 210 m wide, 105 m each side of the runway centerline (67.5 m beyond the paved area).

Runway end safety areas shall be provided at each end of the runway strip for a minimum distance of 90 m beyond the end of the strip and 120 m wide. This will be a clear, graded area provided in case an aircraft under runs or overshoots the runway.

From the point of view of the existing runway lengths, the analysis shows that:

- Nacala is the only airport that can operate Code C aircraft with a 100% payload but with a range limited to domestic and some international airports such as Johannesburg and Cape Town in South Africa, Lilongwe in Malawi and Mauritius.
- For 90 % all cargo payload, Nacala's runway does not need an extension for passenger and belly-cargo aircraft and only 200 meters extension for all-cargo aircraft.
- In order to accommodate passenger aircraft with a 90% payload, Pemba's runways need extensions which measure up to 300 meters in length.
- In order to accommodate all-cargo aircraft with a 90% payload, Pemba's runways need extensions which measure up to 900 meters in length.

Table 7.4 Aircraft Expected to Serve the Nacala and Pemba Airports 2008-2028

Aircraft Type	ICAO Aerodrome Reference Code
B-737-300/400/500	4C
A310	4D
A320	4C
A340*	4E
B-747-100*	4E

*occasional use only

Table 7.5 shows the runway length extensions, in meters, which will be needed in order to serve the 9,000 kilometer range cities with 90% and 100% payloads.

The existing ground contours at the Pemba airfield drop considerably to the northeast approach area to 35 meters from the existing runway elevation, to elevations which are at least 10 to 15 meters below the runway threshold area. This north approach area (Threshold 17) shows some room for runway extensions for the development of the runway and runway end safety area.

Table 7.5 Required Runway Length Extensions and Associated Payload Factors

		100 % Payload		90 % Payload	
		Code D	Code E	Code D	Code E
Nacala	Pax & Baggage	100 m	200 m	0	0
	Cargo	300 m	900 m	100 m	200 m
Pemba	Pax & Baggage	1,000 m	900 m	300 m	200 m
	Cargo	1,000 m	1,700 m	800 m	900 m

In conclusion, Nacala Airport has the best overall runway conditions of the two airports for the operation of an international long haul airport for the Northern Coastal region, for the following reasons:

- Nacala airport runway has the greatest aircraft payload capacity.
- Nacala airport needs the shortest runway extension.
- Pemba airport has a lower payload capacity.
- Pemba airport requires a considerable runway extension.
- Expansion of the Pemba airport airfield is limited by the terrain at the site.

For the Airside Area (runway, taxiways and aircraft parking aprons) AAROTEC used the Advisory Circular AC 150/5060-5, Airport Capacity and Delay, by Federal Aviation Administration (FAA) of the U.S. Department of Transportation. The identification for compliance with international standards was carried out using the ICAO International Standards and Recommended Practices, Aerodromes, Annex 14 to the Convention on International Civil Aviation, Volume I, Aerodrome Design and Operations, Third Edition - July 1999. For the Landside Area (Passenger Terminal Buildings) the consultant used the IATA Airport Development Reference Manual.

Annual and peak hour operations are the factors that trigger the need for runway and associated taxiway development. The number of aircraft operations is dependent on the number of passengers, amount of air cargo and general aviation handled at the airport, as well as the military aviation activity. The hourly runway capacity was estimated and a comparison made of projected annual aircraft demand with the estimated Annual Service Volume (ASV) for the Airports. The ASV is a measure of the number of aircraft operations that can occur at an airport without significant delay. It is a function of the layout of runway and taxiway system, the weather conditions over the year, the types of aircraft operating at the airport and the number of aircraft operations occurring during the peak hours of the day.

Table 7.6 shows the ASV and hourly runway capacity for each airport versus the forecasted operations for the year 2024.

Table 7.6 Airport ASV & Hourly Runway Capacity

Airport	Annual Volume	Hourly Capacity	2028 Forecast Operations Base Case
Nacala	195,000	44	12,528
Pemba	105,000	24	14,685

The above table shows that from the point of view of the forecast number of aircraft operations, neither of the airports will require additional airside area infrastructure. A single runway will therefore be sufficient for the duration of the planning period at both airports. At less than 7,000 operations, the forecast hourly demand is only a fraction of the capacity of even a single runway. It is estimated that the maximum number of hourly operations could reach 20 to 30 by the year 2028. Even under these circumstances, the single-runway capacity is nearly 40 operations per hour, still only half the worst case scenario that is expected.

Parallel taxiway systems are low priority items and are required if congestion on the runway becomes a problem and compromises safety. The graded taxiway strip requirement is 38 m which is the width of the taxiway with 7.5 m wide paved shoulders on each side. The Nacala airport airfield contains a full length parallel taxiway which should be maintained along with the runway, however lighting of the taxiway can be delayed for several years. The Pemba airport airfield does not have a parallel taxiway and it is not needed at this time because of the low volume of traffic.

7.1.2 Apron Requirements

The apron will be sized to provide space for the expected aircraft to enter and depart the assigned spaces under their own power. Therefore, sufficient space must be available for aircraft to park and maneuver. Sizing an airport apron typically involves the use of formulas that are adapted to airports with loading bridges. This method requires an accurate measurement of the time during which the aircraft actually occupies the gate, known as the "mean occupancy time." However, at Pemba and Nacala Airports, considering that the projected volume of traffic is very light, the "mean occupancy time" method is not particularly useful. A simplified version to determine the required number of apron stands (or positions) consists of analyzing the design peak hour activity. For the study period, it is anticipated that the peak hour activity at these airports will consist of two departures and two arrivals. With one aircraft parked at a gate, this would indicate that the airport would require a maximum of three aircraft gates or parking stands. Two of those positions should be for domestic/regional traffic involving B737-400 and A320 aircraft, and one additional position should accommodate an international flight by an A310 aircraft. A remote position should also be available for occasional larger aircraft or for extended parking due to maintenance.

During the initial phase, commercial aircraft at these airports will likely range in size from the RJ100 and B737 to the larger long-range airplanes. The typical aircraft mix will include the B737-400, B767, A320 and A310. Due to their wider wingspan and low number of expected operations, larger aircraft should park in a remote position on the

apron. Aircraft that use the airport more frequently should be able to park adjacent to the terminal building.

It is not anticipated that the either of these airports will serve as a hub airport for any airlines during the planning period. Therefore, no overnight or extended parking areas for aircraft will be provided.

The apron must be able to withstand the loads of aircraft and ground service equipment. A common hazard on aprons is fuel spills. Because of this possibility it is expected or recommended that the apron pavement be constructed with Portland cement concrete. To prevent environmental pollution, strip drains should be included to collect spilled fuel and divert it to an oil/water separator.

According to the presented forecasts the following Table 7.7 indicates the required number of aircraft parking positions during the peak hour for each airport below):

Table 7.7 Required Number of Apron Stands (Peak Hour)

Airport	Year					
	Existing	2008	2013	2018	2023	2028
Nacala	2	1	2	2	2	3
Pemba	2	2	2	2	2	2

Table 7.7 shows that neither airport requires additional apron infrastructure until the year 2028.

7.1.3 Terminal Building Requirements

One of the key infrastructure elements of the airport is the Passenger Terminal Building. This building must provide for acceptable levels of passenger comfort, convenience, safety and security by maintaining a specified Level of Service. It serves as the interface between landside and airside. Terminal facilities consist of ticketing, check-in, security screening, waiting areas, arrival halls, immigration and customs, and access to ground transportation. Auxiliary facilities include concessions, such as duty-free shops, gift shops, newspaper stands, car rental agencies, and restaurants and snack bars.

The size of the terminal building must be determined from the typical peak hour passenger forecast which is a function of the total annual passengers and the distribution of passengers throughout the day. For low-activity airports, the peak hour may be the only hour that an airport terminal is used by passengers. At busy airports, aircraft arrive and depart throughout the day, but certain periods are far busier than others. This fluctuation loosely resembles a normal distribution curve. At the proposed new Nacala International Airport, the level of passenger traffic is expected to start out at low levels and then increase dramatically during the study period.

The Level of Service (LOS) is the assessment of the Passenger Terminal's ability to satisfy the passenger volume processing requirements within the LOS Performance

Criteria established by IATA in its Airport Development Reference Manual, April 1995. It is difficult to establish a precise, quantified relationship between available space, time and Level of Service. Many factors, such as passenger behavior patterns, psychological requirements, passenger comfort can affect the space required in relation to the occupancy time. Level of Service Category 'C' was selected as the minimum design objective as it denotes good service at a reasonable cost. LOS Category 'C' was selected by the Consultant of a previous study for the development of the Airports as a result of years of planning for airport facilities similar to the airports under consideration.

Table 7.8 shows the number of square meters per Terminal Building User specified by IATA for the Category 'C' Level of Service:

Table 7.8 IATA Level of Service 'C' Required Terminal Area per User (m^2)

Check-in Area	1.4
Wait/Circulate	1.9
Hold Room	1.0
Bag Claim Areas	1.6
Government Services	1.0
Commercial & Concessions	3.1
Total	**10.0**

With the LOS 'C' set at 10 m^2 per Peak Hour Passenger, the following Table 7.9 shows the capacity of the existing Passenger Terminal Building at Pemba Airport.

Table 7.9 Existing Terminal Building Capacity

Airport	Existing Terminal Area (m^2)	Capacity (Passengers/hour)	Number of aircraft per hour (60 min turn-around)
Pemba	1,100	110	1 x B737 or 3 x EMB120

The information in the above Table 7.9 shows that the existing Pemba passenger terminal Building can process existing and future traffic demands without the need to expand the facilities, based upon this analysis,. However in real terms the terminal should be expanded presently to accommodate larger aircraft. Additionally, the present gross area is partially occupied by other services such as gift shops, administrative offices and VIP lounges. Should these uses of space be subtracted from the gross space the terminal may not be adequate.

An analysis of the distribution of arrivals at Mozambique airports shows that small airports have two arrivals during the day (and two departures), and each arrival and departure sequence happens at different times during the day. In other words, it is unlikely that both arrivals will occur during the same hour. At busier airports, such as Nampula and Maputo, the peak arrival hour is 15:00, with arrivals and departures occurring throughout the day. However, the majority of arrivals occur within three hours of the peak hour. In other words, over half the arrivals occur during one quarter of the day.

For the level of activity expected at either Pemba or Nacala the airport initially, the busy hour should contain half of all the daily activity. As the airport grows, activity during the busy hour will reduce to around 20 percent of the total daily activity. This is due to a greater number flights distributed more evenly throughout the day.

A second method to compute the space requirements for a terminal building are all based on the typical peak hour passenger (TPHP) count. The design peak hour is not the busiest hour during the year, but rather the 30th busiest hour of the year. The typical peak hour passenger count implies that the level of activity is not out of the ordinary, as would be the absolute peak hour. The space requirements, then, are simply a ratio of a certain area per TPHP. In the United States, the Federal Aviation Administration recommends 13 to 22 m^2/TPHP, while in Europe the range is typically between 30 and 35 m^2. At the other end of the spectrum are the airports in the Far East, which tend to be designed with generous spaces (with the exception of Narita Airport in Tokyo), with vast circulation halls, averaging around 40 to 45 m^2. per TPHP. The International Air Transport Association (IATA) recommends 14 m^2 per domestic TPHP and 24 m^2. per international TPHP. Space requirements for international passengers are greater due to special facilities required for international traffic, such as customs inspection, agricultural inspection, and passport control.

The overall terminal building space requirement was determined from the TPHP distribution for domestic and international passengers and the IATA space recommendations, as indicated in the following Table 7.10. An even distribution of passengers throughout the year was assumed.

Table 7.10 Airport Terminal Requirements

Airport	Year					
	Existing	2008	2013	2018	2023	2028
Pemba						
Domestic TPHP	65	69	89	116	152	200
International TPHP	0	0	71	138	132	255
Space Requirement (m^2)	1,100	965	3,050	4,936	5,306	8,920
Nacala						
Domestic TPHP	0	0	84	121	169	238
International TPHP	0	0	70	137	132	254
Space Requirement (m^2)	0	0	2,856	4,982	5,534	9,428

According to the forecasts presented in Section 3 of the present report, the following Table 7.11 describes the required terminal processing areas for the Airports. To allow for additional space for commercial and other support activities, it is recommended that the first phase of construction should allow approximately 4,000 m^2 for the enclosed floor area of the terminal facilities.

Table 7.11 20-year Area Requirements of Terminal Buildings (m^2)

Year	Existing	2008	2013	2018	2023	2028
Nacala	0	0	2,856	4,982	5,534	9,428
Pemba	1,100	965	3,050	4,936	5,306	8,920

New Nacala Airport Terminal Construction

Based on the recommendation for a new passenger terminal building at Nacala airport, a conceptual cost estimate has been prepared to provide a one-level facility measuring approximately 4,000 m^2, for the initial phase of the development.

The proposed new passenger terminal building construction consists of the following elements:

1. Foundations – spread footings
2. Building shell – reinforced concrete construction
3. Building fenestration — glazed windows and decorative concrete blocks for natural flow-through ventilation
4. Roof – precast concrete roof panels
5. Architectural finishes — textured stucco
6. Mechanical and electrical systems including fire protection
7. High ceilings, ceiling fans and clerestory windows for natural flow-through air ventilation
8. Information technology systems
9. Furniture, fixtures and equipment (seating, counters, tables and trash bins, etc.)
10. Utility services including sewer, drainage and power

Existing Pemba Passenger Terminal Remodeling Project

Pemba airport will require a limited program of expansion, refurbishment and maintenance repairs in order to bring the existing terminal to acceptable standards. The following work has been included for the initial phase of the development:

1. Light roof repairs
2. Light remodeling of existing spaces (painting and minor repairs)
3. Furniture, fixtures and equipment (seating, trash bins, etc.)
4. Minor electrical and mechanical upgrades
5. Signage
6. Enlargement of the departures areas

7.1.4 Cargo Terminal Requirements

The computation of the space requirements for a cargo terminal is a function of a variety of factors, which affect the function and the size of the building. Besides the obvious

importance of the yearly volume of cargo, presented as "yearly throughput," the other critical elements are "peak hour flow" to compute the number of doors required and "peak day flow" to compute the number of storing racks. In addition, other characteristics such as the storage time, or "dwell time," for imports and exports, will greatly affect the type and size of building required.

In this section, however, only the required gross area will be computed. One of the guidelines often used in the design of air cargo terminals is the system formerly used by one of the major air cargo carriers in the United States. In that system, the gross area of the cargo terminal is computed in terms of kg/square meter/year, which has two main classifications.

- Domestic + Export = 13,500 to 22,500 kg/m^2/yr
- Import = 5,500 kg/m^2/yr

The lower figure for import is intended to take into consideration the additional space needed to accommodate customs verification and the longer dwell time of imports. The possibility exists that customs might want to inspect the export cargo. If that were the case, both international imports and exports should be lumped together, with a design unit of 5,500 kg/s.m./yr. However, after consideration, the decision was made to apply the international standard instead for many reasons. First, in actuality, export merchandise is not verified; second, and most important, the adoption of such practice would considerably slow cargo processing and have a negative effect on the whole export trade. As in the case of passenger baggage, the assumption can be made that only spot-checking of export cargo will take place.

Assuming a standard of 15,000 kg/m^2 for domestic and export cargo, the following required gross areas result from the above.

Table 7.12 Gross Area Requirements for Cargo Terminal, 2008-2028 (m^2)

	2008	2018	2028
Domestic and Export Area (@ 15,000 (kg/ m^2/yr.)	206	1598	3770
Import Area (@ 5,500 (kg/ m^2/yr.)	55	463	726
Total Required Gross Area (m^2)	261	2061	4496

The cargo building will include office facilities located in the center of the building between the domestic and the international processing area.

The cargo space requirements above were based on using criteria for gross building area. The next step would be to use other standards which would allow the computation of detailed interior space, such as breakdown and build-up (palletizing) areas, number of doors, etc. In this facility, the cargo tonnage is forecast to be fairly low for the first few years so that these computations would result in small, insignificant areas. Instead, it was decided to use a more general design approach to accommodate for future cargo volume by basing the size of the facility on a greater area than that projected for the initial few years of operation. The building will be designed to allow for easy modular

expansion as the increase in cargo volume warrants. This approach presents the additional advantage that the terminal will be easier to expand based on the 2018 or even 2028 demand.

The principal functional spaces according to the flow of cargo include:

- Domestic import = 528 m^2
  - Receiving, cargo breakdown, delivery/shipping
- Domestic export = 144 m^2
  - Receiving, cargo build-up, delivery/shipping
  - Periodic customs checks can take place in the cargo build-up area.
- International imports = 192 m^2
  - Receiving, customs verification, cargo breakdown, delivery/shipping
- International exports = 96 m^2
  - Receiving, cargo build-up, shipping

7.1.5 Control Tower/ATC Facility/ARFF Building

Control Tower

The control tower is a simple building with, from the top down, a cab for the controllers, a transition room, an electronic equipment room, an ARFF observation watch room, and stairs for vertical conveyance. The tower will be calculated, as dictated by the standard FAA computation method to ensure that the line of sight from the tower cab eye level intersects the grade of the airport traffic.

The main function of a control tower is to facilitate the efficient work of the controllers in their management of traffic. To that end, a few conditions must be met:

- The tower cab should have adequate equipment, installed in a logical, efficient manner. This aspect is covered in the requirements for navaids and communications.
- The controllers must have complete visibility of every point of the runway, taxiway and apron, as well as the approach and departure paths. The minimum angle for the line of sight between a controller's eye height (considered at 1.5 m above the cab floor level) and the ground surface at any point on a controlled movement area, and at both runway thresholds, should be at least 35 minutes. Siting the tower near the mid-point of the runway minimizes the required height, and avoids the interference of parked aircraft with the controller's line of sight.

ATC Equipment Building

A two-story structure with ATC facilities, offices, equipment and repair shops on the ground floor and additional offices (common and private) on the second floor. The requirement for the second floor of offices is dictated by the anticipated number of ATC employees. The total floor area is estimated at 1000 m^2.

ARFF Facility

The ARFF facility should be located either directly on the apron or taxiway, or on a dedicated road having direct access to the airfield, in order to reach any part of the airfield in two minutes. The optimum location is usually as close to the mid-point of the runway/taxiway system as possible. A first-aid room is incorporated in the ARFF facility, and an ambulance is planned to be stationed at the ARFF building.

Following ICAO Annex 14, the minimum number of fire fighting vehicles is two and should include:

1. One rapid intervention vehicle (RIV)
2. One large size vehicle capable of discharging fire fighting foam at a rate of 5,300 L/min. or two medium size vehicles

The basic concept of the building consists in grouping three facilities around a common central lobby, where the vertical circulation of the control tower is also located. The buildings are designed as follows:

The building consists of protected parking for three vehicles around which are "wrapped" the secondary functions. The stairs indicated in the training room lead to a lounge-mezzanine above, which takes advantage of the high ceiling of the garage. The total floor area is estimated at 700 m^2.

7.1.6 Aircraft Maintenance Hangar Requirements

It is not anticipated that aircraft maintenance will be performed at either of these airports initially. Currently maintenance of aircraft is performed elsewhere. With the size of the airlines fleets, it would not be economical to establish another major maintenance base at Nacala or Pemba airport. However, as future traffic increases and foreign carriers start utilizing the airport, the need for a hangar may arise. For this reason an area on the airport has been shown for future development of an aircraft maintenance area including a hangar.

7.1.7 Airfield Maintenance Building Requirements

It will be necessary to house airfield maintenance equipment for the new airport. This equipment includes a sweeper and mower to keep the runway clean and the grass cut. This facility should be a simple building with sufficient number of bays capable of storing

and maintaining the vehicles and will include room to keep spare parts as well as basic offices for the maintenance personnel. The building will be designed so that additional bays can be added easily for future expansion if it is needed.

7.1.8 Aircraft Fueling Facilities

It is recommended that fuel for the aircraft be delivered by trucks as opposed to a hydrant system at the gates and at apron parking positions. A fueling hydrant system would be very expensive. In addition, fueling by a hydrant system can more easily lead to spillage which can then become a major environmental concern.

7.1.9 Navaids, Visual Aids, and Meteorological Equipment

Weather is always a consideration when landing, taking off and flying for any aircraft and therefore must be considered in assessing the orientation of the runways as well as the required weather instrumentation and navigational aids. The Northern Mozambique coastal area is influenced by a monsoon regime. Some cyclones originating in the Indian Ocean reach the coastal zones of Nacala, Mossuril and Monapo and lose force as they move to the interior.

The study area is located in a region where two climatic regimes overlap, the East African Monsoon System in which air circulation alternates between NE during the southern summer and SW during- winter, and the Indian Ocean Subtropical Anticyclone System that rules the dominant easterlies. As a consequence, the predominant wind directions as recorded at Beira during the last 25 years are from ENE to SE. Although the frequency of winds stronger than 10 m.s' is typically less than 1% from February to August and about 1-2% from September to January, the region is regularly struck by tropical storms originating in the central Indian Ocean. These devastating storms occur mostly from November to April and may feature winds of gale force (greater than 60 km/h) and large amounts of precipitation. The annual frequency of occurrence of these storms in the Mozambique Channel was 3.1 in the period between 1911 and 1960. During tropical storms, rainfall may be far above the mean values, e.g. 347.3mm of rain in 24 hours, recorded at Beira in March 1986. According to statistics from the *Istituto Nacional de Metereologia*, 23 cyclones have affected the Mozambique coast over the last thirty years.

The rainy season extends from October to March with mean monthly precipitation ranging from 92mm in October to 217 mm in March. The dry season extends from April to September with mean monthly precipitation ranging from 0.9 mm in April to 42.74 mm in September. Mean annual rainfall is 800mm.

Fog is generally uncommon. During May until September, visibility is limited to about one kilometer during approximately 1% of the time. In the wet season, visibility can be poor during heavy rainfall.

The climate of Nacala and Pemba is marked by very high relative humidity (80%) and a mean annual monthly temperature of 26°C with a peak in December (32°C) and a low in July

(18°C). Two seasons are alternated with different pluvial regimes but without great temperature variation. The rainy season occurs between the months of November and March, with maximum values in the last two months of the year. Winters are dry and, from April to October, the monthly average values never exceed 50 mm.

Electronic Aids

The weather conditions and forecast traffic do not dictate that the selected airport be made a CAT I airport at this time, although an international airport should be designed with future capability to continue operations under instrument meteorological conditions. In order to satisfy this requirement, preparations for navaids for Category I approaches must be included in the design and construction. A complete ILS should include localizer and glide slope transmitters, and outer and middle markers. The runway and taxiway markings should also be designed for compatibility with this requirement as will the runway edge and centerline lighting. In addition, base cans with embedded electrical conduits will be placed during construction of the runway and taxiway pavements for possible future upgrading for Category II approaches with touchdown zone (TDZ) lights and taxiway centerline lighting. A Cat I approach lighting system should be considered for approaches from the North. Another electronic aid to be considered for the new airport facilities is a Very High Frequency Omni Range with Distance Measuring Equipment (VOR/DME).

The selected International Airport should be provided with a complete instrument landing system (ILS) at some future date, which includes the following components:

- Outer Marker
- Middle Marker
- Glide Slope Transmitter
- Localizer Transmitter

The sites for the outer and middle markers will be outside the boundaries of the airport proper, therefore the site acquisition should be enacted by ADM. It will be necessary to provide a building or shelter having a space of approximately 10 for selected electronic equipment associated with the ILS components listed above.

ADM has not indicated that there is a need at this time to install radar facilities at the selected international site. However, the modifications and additions to the airspace plan resulting from the inauguration of this airport may require the addition of a VOR/DME at or near the airport site. At some future date, it may be necessary to install runway visual range (RVR) transmitters and receivers. This decision cannot be made at this time due to the lack of information regarding weather condition observations at the site.

Visual Aids

Visual aids will include the precision approach path indicator (PAPI), airport beacon and runway end identifier lights (REILs) at both runway ends. These items are used primarily

during visual flying conditions. Visual aids at this airport will consist of the following items:

- High-intensity runway edge lighting (HIRL)
- Runway centerline lighting
- Runway end identifier lights (REILs)
- Provision for future touchdown zone lights (TDZ)
- Precision approach path indicators (PAPIs), at both ends of runway
- Sequenced flashing approach lighting system for R/W 22 (ALSF-2)
- Taxiway edge lighting (MITL)
- Provision for future taxiway centerline lights.
- Runway marking in accordance with the ICAO recommendations for precision runway operations
- Taxiway marking consisting of centerline and side stripes and holding markers
- Angled marking for all paved shoulders

Meteorological Services and Equipment

The meteorological services office (met) in the air traffic control tower facility will provide weather observation and reporting services for the area. Such services include monitoring weather conditions, disseminating local weather conditions and forecasts to pilots in person or by radio, communicating routinely with other national weather offices, collecting current and forecast weather data at distant airports as requested by pilots, and administering flight plans. All activities should be conducted in accordance with national aviation weather reporting requirements and ICAO Annex 3.

Weather observers will observe, record and transmit meteorological information as required by ICAO and government standards. Observers will record sky condition, cloud cover and type, temperature, dew point, surface wind direction and speed, winds aloft direction and speed at selected altitudes, surface barometric pressure, precipitation, restrictions to visibility, and miscellaneous weather information. Observations will be made at the intervals and in the manner prescribed by the weather authorities. Local weather data should be read directly from specially manufactured and carefully calibrated weather observation instruments. Automatic recording instruments should be used to keep an accurate, permanent record of weather conditions at the airport.

Automated weather observing systems (AWOS) and automated surface observing systems (ASOS) are computerized systems that automatically observe weather conditions at an airport and report them through a synthesized human voice by way of radio or telephone. Systems are readily available from vendors and are typically programmed to respond in English, although other languages are available. Automated systems currently have some limitations that humans do not; as technology develops, these limitations may be reduced or totally eliminated.

One of the key responsibilities of aviation weather reporting services is to disseminate weather information to aircraft pilots and airline dispatchers. Weather information comes from local and distant sources. A briefing station in the weather office should be

sufficient for local weather reports. Local weather data should be displayed directly and easily conveyed to the pilot, dispatcher or weather briefer. Weather information from distant areas (e.g., destination cities) must be communicated to the weather office through a national weather data center or from the many sources of weather information. A national data center is more efficient for this purpose. Local weather briefers should be able to call up, display and print weather data for any airport. Appropriate graphics (e.g., weather charts, weather radar reports and satellite photos) should be available also that would be used to present a complete weather picture to the user or the weather service specialist.

Communication is vital for the functions of the met office. In addition to communicating with other weather offices, specialists should be able to relay weather information directly to pilots and other users. The met office, therefore, should be capable of communicating with aircraft on published aeronautical frequencies or through mode S transponder data link transmissions. Dedicated phone lines between the met office and other met offices and air traffic service facilities would ensure that information is efficiently transmitted. Local weather information should also be displayed in the tower cab to allow air traffic controllers to pass on current local weather information to pilots.

Met office specialists may also administer flight plans. This duty relieves some of the burden of air traffic controllers. After providing a weather briefing to the pilot or dispatcher, the met specialist can then accept a flight plan and relay that information to air traffic services. Departure clearances and instructions should be transmitted by air traffic controllers.

With the initiation of operations at this site, certain minimum meteorological equipment should be provided. This will include temperature/dew point gauge, anemometer, barometer, rain gauge, ceilometers, and a runway visual range transmitter and receiver. A more complete listing and description of meteorological equipment will be developed in the report.

7.1.10 Access Roads and Auto Parking

The proposed airport improvements and traffic will dictate the phasing and design and construction of an access road to serve the airport at some future time. The airports will have to provide adequate parking areas to serve the forecast peak hour passenger traffic, airport employees, airport visitors, airline employees and concessionaires in a location suitable for each type of use. External road patterns may have to be improved to avoid congestion and improve safety.

7.1.11 Water Supply and Sewage Treatment Plant

The airport water supply will be separate and designed to provide an adequate supply of potable water with a storage tank large enough to contain at least a week's supply or an amount required under local codes for fire fighting, whichever is greater. The distribution

system should provide an adequate supply of treated water for the airport staff and employees as well as the passengers who pass through the terminal.

The airport design will include provision for an on-site sewage treatment plant with a collection system to serve all of the proposed buildings on the site. The level of treatment from this plant will be established during the final design phase in accordance with local codes and environmental restrictions in force.

7.2 Summary of Airport Infrastructure Development Needs

This section provides a summary of the major infrastructure development investments needs required for each of the Airports, in order to comply with ICAO standards.

7.2.1 Nacala Airport

1. Runway pavement overlay
2. Runway shoulders
3. Runway end safety areas
4. All visual aids for navigation
5. Equipment and electrical installations
6. Emergency services
7. Air traffic control tower and associated communications equipment
8. Perimeter fence and perimeter road

In addition to the above, conversion of the existing Nacala military airfield to civilian service will require the construction of the following airport landside facilities:

1. Passenger terminal building
2. Air traffic control tower
3. Aircraft fire-fighting and rescue facility (AFFR)
4. Air cargo terminal
5. Airfield maintenance facilities
6. Access roads and parking facilities
7. Other support services and utilities

7.2.2 Pemba Airport

Following is a summary of the major infrastructure development investment needs to comply with ICAO Standards, for a Code 4-C Aerodrome with non- precision approach procedures:

1. Runway pavement overlay,
2. Runway end safety areas,
3. Some visual aids for navigation such as signaling, markings and aeronautical beacon,
4. Upgrade emergency Services,

5. Perimeter fence and road.

In addition to the above, expansion of Pemba airport will require the construction of the following airport landside improvements:

1. Expansion of the passenger terminal building
2. Improvement of the landside road and parking facilities

7.3 Summary of Investment Needs

Tables 7.13 and 7.14 show a list of investment needs which will be required to be accomplished within the first 3 years of the initial development and operations period at the two airports. The list of investment needs is based on the Consultant's visual inspection of the existing facilities at each of the airports, demand/capacity considerations and application of ICAO, IATA and FAA international standards and recommendations.

Table 7.13 Nacala Airport Initial Compliance Requirements & Investment Needs

Project	Description	Trigger	Purpose
Airside	Phase 1 Code 4-D; Phase 2 Code 4-E		
Runway 01/19			
Runway Resurfacing	Asphalt 10 cm	ICAO	Safety
Runway Shoulders	7.5 m both sides, asphalt 6cm	ICAO	Safety
Runway End Safety Areas.	90X90 m both thresholds, asphalt 6 cm	ICAO	Safety
Taxiways and aprons			Safety
Taxiway Resurfacing	Asphalt 10 cm	ICAO	Safety
Access taxiway shoulders	7.5 m both sides; asphalt 6 cm	ICAO	Safety
Apron			
Access Taxiway Resurfacing	Asphalt 10 cm	ICAO	Safety
Access Taxiway Shoulders	7.5 m both sides; asphalt 6 cm	ICAO	Safety
Civil Apron Resurfacing	Asphalt 10 cm	ICAO	Safety
Apron Shoulders	7.5 m; asphalt 6 cm	ICAO	Safety
Visual Aids			
Approach Lights	Simplified Approach Lighting System	ICAO	Safety
Visual Approach Indicator	PAPI	ICAO	Safety
Runway Threshold/end Lights	Red–Green	ICAO	Safety
Runway Edge Lights	White	LCAO	Safety
Taxiway Edge Lights	Blue		Safety
Indicators and Signaling	Wind direction and signaling lamp		Safety
Marking	Vertical and horizontal (painting)	LCAO	Safety
Equipment + Installation			
Emergency Generators		LCAO	Safety
Rescue and Fire Fighting Eq't.	Civil works; Cat 7 eq't to be provided by ADM		Safety
Tow Tug	Ramp tractor	Apron	Operations
Ground Service Equipment	Loader, baggage carts, conveyor belts, etc.		Operations
Perimeter Fence		ICAO	Safety
Perimeter Road		ICAO	Safety
Landside			
Access Road	1600 m from existing public road		Operations

Parking Area			Operations
Terminal Building	New building 4000 m^2		Operations
Terminal Building	Furniture, fixtures & eq't. (FFE)		Operations
Technical Infrastructure			
Air Traffic Control Tower	Rehabilitation of existing facilities	ICAO	Safety
ATC Equipment	Air traffic control tower cab unit and eq't.	ICAO	Safety
High Tension Electrical Supply	11 kw		Operations
Electrical Substation	Transformers 300 kw		Operations
Emergency Generators	1 of 250 Kva + 1 of 100 kva		Operations
Water Supply and Treatment Plant			Environment
Wastewater Treatment Plant			Environment
Telephone Supply	Microwave access for 100 lines		Operations
Fuel Farm			Operations
Incinerator			Environment

Table 7.14 Pemba Airport Compliance Requirements & Investment Needs

Project	Description	Trigger	Purpose
Airside (ICAO Code 4-C)			
Runway 17/35			
Runway Resurfacing	Asphalt 6 cm	ICAO	Safety
Runway End Safety Areas	90 x 90 m both thresholds; asphalt 6 cm	ICAO	Safety
Taxiways and Aprons			
Taxiway Resurfacing	Asphalt 6 cm	ICAO	Safety
Civil Apron Resurfacing	Asphalt 6 cm	ICAO	Safety
Apron Shoulders	3.5 m; asphalt 6 cm	ICAO	Safety
Visual Aids			
Aeronautical Beacons	Aerodrome Beacon	ICAO	Safety
Indicators and Signaling	Wind direction and signaling lamp	ICAO	Safety
Marking	Vertical and horizontal (painting)	ICAO	Safety
Perimeter Fence		ICAO	Safety
Perimeter Road		ICAO	Safety
Landside			
Access Roads, etc.	Terminal building roads/parking, asphalt 6 cm		Operations
Terminal Building	Remodeling + expansion		Operations
Terminal Building	Furniture, fixtures + eq't.		Operations
Technical Infrastructure			
Wastewater Treatment Plant			Environment
Incinerator			Environment

7.4 Cost of Investment

Introduction

AAROTEC has prepared the cost of the investments needed for implementation of the prioritized development plan to ensure that the most pressing needs of the selected international airport, in terms of facilities, equipment and maintenance.

Preliminary estimates have been developed based on the recommendations listed in Tables 7.14 and 7.15 above. These cost estimates include engineering costs and capital costs for each of the proposed developments, and are based on local unit costs.

The estimates are to be considered as a conceptual estimate. Further studies and investigations will provide a more detailed source to create an accurate quantity and pricing scheme.

7.4.1 Capital Investment Program for International Airport Facilities

Capital investment projects required to provide the necessary facilities to accommodate international airline services were divided into the following categories:

1. Airside
2. Landside
3. Navaids and specialty equipment
4. Other support projects

The following Table 7.15 shows a summary of a phased capital investment program related to the provision of facilities to accommodate international airline services at both Pemba and Nacala. Table 7.16 presents a comparison of different scenarios for the phased development of both international and regional/domestic facilities at both airports. Table 7.17 provides details of the costs of the specialized equipment required for the development of the new commercial airport facilities at Nacala.

Table 7.15 Summary of Capital Investment Program for International Airports

	Investment Program (USD x 1000)						
	2009	2010	2013	2018	2023	2028	Total
Nacala							
Airside Works	2,665	1,776	1,776	1,332	1,332		8,882
Passenger Terminal	6,000		5,000		5,000	5,000	21,000
Landside Works	1,672	1,229	1,672	1,115			5,687
Navaida + Eqpt.	1,635	3,796	2,160	1,636	1,636		10,863
Cargo Terminal	61	81	53				1945
Repaving				2,044		2,044	4,088
Total Nacala	**12,032**	**6,882**	**10,661**	**6,126**	**7,968**	**7,044**	**50,714**
Pemba							
Airside Works	7,500	5,000	6,500				22,500
Passenger Terminal	12,000	3,500	8,000		1,850		25,350
Landside Works	1,221	1,294	1,221				3,736
Cargo Terminal		4,000				4,000	8,000
Navaids + Eqpt.	146	194	146				486
Repaving				1,149		1,149	2,298
Total Pemba	**20,866**	**13,989**	**15,866**	**1,149**	**1,850**	**5,149**	**58,869**

Table 7.16 Comparison of Alternative Dev't Scenarios for Pemba and Nacala

	Investment Requirements (USD x 1000)						
	2009	2010	2013	2018	2023	2028	Total
Pemba Regional and Nacala International							
Pemba Regional	5,000	8,500	1,323	8,500	12,000	2,200	37,523
Nacala International	12,032	6,882	10,661	6,126	7,966	7,044	50,714
Totals							**88,237**
Pemba International and Nacala Regional							
Pemba International	20,866	13,989	15,866	1,149	1,850	5,149	58,869
Nacala Regional	5,000	8,500	3,500	2,500	3,000	2,200	24,700
Totals							**83,569**
Pemba and Nacala International							
Pemba International	20,866	13,989	15,866	1,149	1,850	5,149	58,869
Nacala International	12,032	6,882	10,661	6,126	7,968	7,044	50,714
Totals							**109,583**

Table 7.17 Cost of Major Equipment at Selected International Airport

Passenger Terminal Equipment	
Baggage claim devices	$332,250
Outbound baggage system	210,000
FIS inspection counters	60,750

X-ray security screening	352,875
Walk-through metal detectors	31,500
Flight information display systems	98,250
Building security access systems	315,938
Subtotal	**$1,401,563**
ARFF Equipment	
ARFF foam tender, 4 x 4 chassis,	$562,500
11,355 L water tank, 1515 L foam, 7570 L/min.	
ARFF foam tender, 4 x 4 chassis,	375,000
5,675 L water tank, 680 foam, 3,785 L/min.	
RIV, 226 kg dry chemical, 1,900 L water,	307,500
225 L foam, 1,900 L/min, including rescue tools	
Ambulance, including rescue tools	165,750
4 fire entry suits & 6 fire fighting suits	56,700
Subtotal	**$1,467,450**

7.4.2 Cost Estimating Methodologies

Due to the early stage of planning, the estimate needs are to be considered as an order of magnitude estimate. Unit costs were extracted from similar projects recently reviewed by the Consultant in terms of scope; productivity rates, material, equipment cost and priced using locally obtained labor rates. In instances when specialized or imported materials were required, historical or quoted prices were used and a freight allowance was applied.

The Engineering, Procurement and Construction (EPC) costs include the following:

1. Contractors overhead and profit
2. Insurance and bonds
3. Value added taxes
4. Conceptual level contingency allowance
5. Design and construction management fees

They do not include the following costs:

1. Any special taxes
2. Any local professional association fees
3. Any inflation escalation factors

No geo-technical engineering information was available during the preparation of the estimate. This estimate assumes that the existing subsurface conditions will allow for conventional shallow foundations and conventional pavement construction without the need of any specialized ground modification technique.

7.4.3 Runway Pavement Rehabilitation Program

The runways at both Nacala and Pemba require rehabilitation, as described in the assessment of existing conditions in Section 2 of the present report. For the purposes of the present exercise, AAROTEC used data developed during a previous study for the Pemba airport runway by BKS Consultants It should be noted that this program was developed prior to a more recent pavement evaluation study at Nacala; therefore, it should only be considered to be a preliminary identification of construction parameters. The program includes the following assumptions:

- The surfaces of the runways will receive a 6 cm overlay, over the entire existing runway surface;
- Runway lighting allowance and navaids in addition to pavement and resurfacing work for Nacala only.

7.4.4 Pavement Designs of Upgrading Works at Pemba

(The following section is extracted from the BKS Report of 2007)

Runway Extension

The flexible pavements have been design for a structural life of 20 years with periodic major maintenance taking place in Year 10. The design philosophy assumes a staged construction in Year 1 whereby the periodic maintenance at Year 10 coincides with a structural strengthening involving an asphalt overlay of 40 mm thick. Not only is this strategy financially more beneficial, but it also involves less risk due to the uncertainties regarding the traffic prediction. In addition, the overlay in Year 10 will take care of environmental degradation of the surfacing (oxidation, aging, etc) which is a common type of distress on airport pavements.

The proposed flexible pavement design for the main runway extension and the new taxiway can thus be summarized as follows:

- 120 mm Continuously graded asphalt surfacing applied in two layers (2 x 40 mm layers in Year I and 40 mm overlay in Year 10)
- 130 mm G2 crushed stone base layer, compacted to 102% of modified AASHTO dry density (MADD), using crushed stone material obtained from existing stone quarry approximately 50 km from Pemba on Road EN1O6 southwards
- 150 mm C3 cement stabilized upper sub-base layer, compacted to 97% of MADD, using in-situ natural red sand
- 200 mm C3 cement stabilized lower sub-base layer, compacted to 97% of MADD, using in-situ natural red sand

- 1000 mm sand selected sub grade I fill compacted to 98 % of MADD, using in-situ natural red sand
- Proof rolling with impact roller or heavy pneumatic roller of the in-situ roadbed material

New Commercial Airline Apron

The rigid pavements at the apron have been design for two scenarios, a structural life of 20 and 30 years with a periodic maintenance taking place at year 10 interval. The periodic maintenance involves localized concrete patching, localized Spalding repairs and resealing of all joints with self-leveling silicone sealant. The design was done using the Led FAA software from FAA. The proposed pavement designs are as follows:

Stands for C Type aircraft (20 years structural design period)

- 300 mm PC Concrete, 4.8 MPa flexural strength
- 200 mm C3 Cement Stabilized Sub base compacted to 97% of MADD
- Fill sand Layer compacted to 98% of MADD
- Proof rolling with impact roller or heavy pneumatic roller of the in-situ roadbed material

Stands for C Type aircraft (30 years structural design period)

- 310 mm PC Concrete, 4.8 MPa flexural strength
- 200 mm C3 Cement Stabilized Sub base compacted to 97% of MADD
- Fill sand Layer compacted to 98% of MADD
- Proof rolling with impact roller or heavy pneumatic roller of the in-situ roadbed material

Stands for E Type aircraft (20 years structural design period)

- 350 mm PC Concrete, 4.8 MPa flexural strength
- 150 mm C3 Cement Stabilized Upper Sub base compacted to 97% of MADD
- 150 mm C3 Cement Stabilized Lower Sub base compacted to 97% of MADD
- Fill sand Layer compacted to 98% of MADD
- Proof rolling with impact roller or heavy pneumatic roller of the in-situ roadbed material

Stands for E Type aircraft (30 years structural design period)

- 370 mm PC Concrete, 4.8 MPa flexural strength
- 150 mm C3 Cement Stabilized Upper Sub base compacted to 97% of MADD
- 150 mm C3 Cement Stabilized Lower Sub base compacted to 97% of MADD
- Fill sand Layer compacted to 98% of MADD
- Proof rolling

Rehabilitation of Existing Pavements

All the existing pavements will have to be rehabilitated or upgraded to take the predicted traffic during the next 20 years. Two scenarios are considered, namely:

- Scenario 1: the Pemba Airport continues to serve only regional flights
- Scenario 2: the Pemba Airport is upgraded to also accommodate intercontinental flights in addition to the regional flights.

Scenario 1: Only Regional Flights

As indicated in Section 3.3.5 of the BKS Report, the existing pavements have sufficient bearing capacity to carry the expected future regional traffic. The major distress in the existing pavements is aggregate loss due to the brittleness of the binder. It is therefore proposed that the existing surfacing be milled-off to a depth of 40 mm and be replaced with a medium continuously graded hot-mix asphalt surfacing with rolled-in chips over all the pavement elements. The asphalt overlay shall be constructed after localized repairs of the base layer where required.

Scenario 2: Regional and Intercontinental Flights

The existing apron is foreseen to be carrying General Aviation flights which are very light. The pavement was evaluated using fire engine truck loadings instead. It was found that localized repair followed by an asphalt overlay of 40mm is adequate. The existing surfacing shall be milled-off prior to the construction of the asphalt overlay. The main runway will have to be upgraded as follows:

- 120 m new continuously graded asphalt surfacing applied in two layers (2 x 40 mm layers in Year I and 40 mm overlay in Year 10)
- 130 mm new G2 crushed stone base layer, compacted to 102% of modified AASHTQ dry density (MADD), using crushed stone material

obtained from existing stone quarry approximately 50 km from Pemba on Road EN1O6 southwards

- 350 mm C3 in-situ recycling of existing layers to a new cement stabilized sub-base constructed and compacted in two layers to 97% of MADD

The repairs to the runway will be challenging as the airport will probably remain open during the construction period. It is envisaged that the runway lengthening will be conducted prior to the rehabilitation actions, which will help in accommodating the traffic. The in-situ recycling of the existing layer will have to be done in several operations as follows:

- Remove the top layer of 90 mm asphalt and 140 mm crushed stone and temporarily blade to windrow
- In-situ recycle and stabilize the lower 200 mm to a lower C3 sub-base
- Blade back the windrowed material and stabilize to an upper 150 mm C3 sub-base layer

Land-side Parking Areas and Access Roads

The pavement designs of the parking areas and access roads on the land-side of the airport will be finalized once the revised layout have been approved. The following was used as a preliminary design in order to establish the cost estimate of the pavement elements:

- 40 mm continuously graded hot-mix asphalt surfacing
- 130 mm 02 crushed stone base layer, compacted to 102% of modified AASHTO dry density (MADD), using crushed stone material obtained from existing stone quarry approximately 50 km from Pemba on Road EN1O6 southwards
- 150 mm C3 cement stabilized upper sub-base layer, compacted to 97% of MADD, using in-situ natural red sand
- 300 mm sand selected sub grade / fill compacted to 98 % of MADD, using in-situ natural red sand
- Proof rolling with impact roller or heavy pneumatic roller of the in-situ roadbed material

Cost Estimate of Proposed Upgrading of Pavement-Related Works

Table 7.18 below summarizes the preliminary cost estimate using the proposed pavement designs described above.

Table 7.18: Cost Estimate of Pavement-Related Upgrade Works

Pavement Element	Scenario 1 Upgrade		Scenario 2 Upgrade	
	Area (m²)	Estimated Cost (USD)	Area m²)	Estimated Cost (USD)
Existing Main Runway	88,788	1,040,088	111,560	4,908,640
Existing Secondary Runway	19,950	233,700	7,635	89,439
Existing Taxiway	3,178	37,228	1,589	18,614
Existing Class B Apron	23,566	276,059	23,566	276,059
Main Runway Extension			84,310	4,131,190
New Taxiway A (Parallel)			153,675	7,530,075
New Taxiway B			5,400	264,600
New Taxiway C & Emergency Apron			26,169	1,151,436
New Threshold 17 (Class E)			14,172	1,326,094
New Threshold 35 (Class E)			13,825	1,293,625
New Class C Apron			2,682	217,625
New Class E Apron			7,312	684,194
New Class B Apron & Airside Access Roads			21,834	566,124
Landside Parking & Access Roads			38,197	990,394
TOTAL COST		1 587 075		23 448,109

7.5 Conclusions and Suggested Alternatives

Much of the above information is taken from previous studies conducted for ADM and current knowledge of the industry. All of the material is very worthwhile, but is beyond the means of either airport, Pemba or Nacala, to amortize a loan program for the amounts estimated. The information may be useful in the event the government of Mozambique acquires grants on behalf of ADM.

The primary objective of the present feasibility study is to recommend the optimal strategy for the implementation of appropriate international airport facilities to serve the Northern coastal region of Mozambique. The recommended strategy considers the cost and benefits of both ultimate and immediate development projects.

In the long term, it appears more beneficial to designate Nacala as an international airport for long-range flights, since there are no foreseeable limits to the development of airport facilities at this site. At the same time, a limited program of minor upgrading and extension of the runway at Pemba appear to offer an economical solution to the pressing issues at that site.

In terms of phased implementation, it is recommended that Nacala be designated immediately and officially as a general aviation airport while being upgraded to the

status of a commercial airport. This can be accomplished with minimal initial investment cost; the airport would then be upgraded progressively to handle charter flights and then international scheduled airline services airport with essential facilities as justified be passenger traffic to the region. This proposed strategy allows both areas to benefit from improved air traffic services in the short and long term.

The following Table 7.19 indicates the level of investment required at each airport to accomplish the primary objective.

The cost of navaids can be reduced to any level to make Nacala development feasible for chartered flights; the minimum consists of visual aids for landings. Approaches can be made off the Pemba NDB. Weather information is not readily available for determining the number of IRF days

Table 7.19 Required Capital Investment Program for Nacala and Pemba Airports (2008-2028)

	Total Investments (USD x 1000)				
	2009	2013	2018	2028	Total
Nacala					
Airside	2,665	3,553		2,665	8,882
Landside	1,672	2,229		1,672	5,573
Navaids & Equip.	2,121	61	920	1,844	4,945
Cargo	60,720	80,960		61	202
Repaving			2,044	2,044	4,087
Total	**6,518**	**7,924**	**2,964**	**8,285**	**23,690**
Pemba					
Airside	1,327	1,770		1,327	4,424
Runway Extension	5,750				5,750,000
Landside	221	294		221	735
Navaids & Equip.	146	194		146	486
Second Departure Lounge	4,500				4,500
Repaving			1,151	1,151	2,302
Total	**11,944**	**2,258**	**1,151**	**2,845**	**18,198**

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Appendix A: Nacala Phase Construction Cost Estimates

SECTION 8: CONCEPTUAL DRAWINGS AND DEVELOPMENT PLANS

8.1 Preliminary Airport Design Parameters

8.1.1 General

The infrastructure design for the Pemba and Nacala airports is based primarily on previous studies. The Consultant's responsibility included reviewing all pertinent documents related to the development of the airports. This included a review of the available data and visits to the sites of the existing facilities. It also included updating the passenger and cargo forecasts to predict the level and type of activity and determine airport facility requirements related to regional and international airline service. The evaluation criteria were updated to confirm the basis for the airport selection process. This update concluded that the design basis for the development of the selected airport, Nacala, should be to accommodate international operations, in addition to domestic and regional operations.

8.1.2 Planning and Design Criteria

The codes, standards and recommendations of the USFAA, ICAO, IATA and Mozambique were used to establish the planning and design criteria for the international airport facilities.

8.1.3 General Basis for Design

Conceptual studies for the passenger terminal, cargo terminal, airport traffic control tower facility and airport rescue and fire fighting facility/airfield maintenance building were based on forecasts of passenger and freight aviation activity and related information contained in other sections of this report. A space analysis for the major functions of each facility was prepared utilizing the Airports Terminals Reference Manual published by the International Air Transport Association (IATA), Annex 14, Aerodromes; of the International Civil Aviation Organization (ICAO) and accepted standards of aviation facility design. Further evaluation and analysis allowed for development of a detailed building area program that identified required spaces and assigned an area calculation to each space. From this program, floor plan drawings were prepared that graphically presented the building space program.

Each of the four buildings designed for the new international airport facilities at Nacala has unique characteristics and functions that were addressed during the design process in order to be functional, economical and yet an aesthetical part of the environment.

Passenger Terminal

The primary function of the passenger terminal is to provide processing, circulation and holding space for users of the facility. Successful terminal design takes into account the needs of passengers and greeters, air carriers, the airport operator and the support staff; however, the main design objective is to accommodate passengers.

The passenger terminal serves as the transfer area between landside and airside functions. The mixed-mode transportation of surface access and air travel requires facilities that provide the following:

- landside interface
- passenger processing
- passenger holding and concessions
- circulation,
- airside interface, and
- air carrier support spaces

Airport Traffic Control Tower Facility

Air traffic control personnel communicate with aircraft and relay clearances and air traffic flight plans. The facility will provide space for the activities related to monitoring, directing and supervising traffic within the airport area. The design reflects the basic functions of the facility, namely relaying weather conditions, communicating air traffic information and providing space for administration and work areas and service equipment. Control tower cab design considerations take into account, *inter alia*, the number of positions required and the function of each position.

Airport Rescue and Fire Fighting Facility

It is essential that well-equipped and well-trained fire departments be maintained at all airports. Due to the limited time of survival in the event of an aircraft crash or fire, a rapid response to the accident site is a major requirement in determining the preferred location of the facility. Response times to any part of the movement area must comply with ICAO recommendations. In locating the ARFF station certain factors must be considered, including immediate and direct access to the airfield, unimpeded access routes, noninterference with the airport traffic controller's line-of-sight, maximum surveillance of the air operations area, airport expansion that would not jeopardize emergency services and minimum obstruction from existing facilities. Design of the facility must also include features and provisions to enhance response capability, including high overhead vehicle doors linked to the alarm system, space for a refrigerated type mobile disaster van, sleeping quarters capable of being utilized as an emergency first aid center and adequate storage of supplies and fire fighting chemicals.

Cargo Terminal

Functions performed at the cargo terminal are similar to those of the passenger terminal even though aspects of the areas are quite different. Four principal functions are served by the cargo terminal: conversion, sorting, storage and documentation.

As the air cargo industry continues to go through technology changes, making air cargo terminals subject to modification, it is imperative that the design approach remain flexible.

From forecast data, design considerations focus on total volume and peaking characteristics of cargo flow. Peak volume will have a direct influence on the design of the various systems for handling cargo. Since airside and landside peaks do not necessarily coincide, storage areas within the cargo terminal balance efforts between airside and landside peaks. The level of sophistication for handling air cargo is a major factor in determining the size and form of the cargo terminal.

The level of sophistication for handling air cargo is a major factor in determining the size and form of the cargo terminal. That sophistication is directly related to the mix and flow characteristics of cargo, types and sizes of both air and surface vehicles, cargo handling techniques, and degree of mechanization (that is, low technology, medium technology or high technology).

8.1.4 Site Works

Site works at both Pemba and Nacala airport facilities consist of two major areas: airside and landside. Airside site work consists of general site preparation, such as clearing, grading and stripping, storm drainage, excavation and embankment and pavement. Landside site work consists of constructing the road network, security fencing, storm drainage, pavement, grading, lighting and other utilities.

As part of the design considerations for the site works, each building is assumed to be readily expandable from a modular design approach, without major interruptions to necessary operational functions. The design approach also allows for expansion that will remain aesthetically compatible with the original design intent. This is accomplished by the select use of materials that wear and weather well and by design techniques that emphasize modular structural systems.

8.1.5 General Design Direction

While a narrative description of each building is contained in this report, with graphic representation drawings forming the total document, key design criteria decisions and directions are described here to indicate issues considered in preparing final conceptual studies.

Passenger Terminal Facilities

Nacala

- Provide a new International Terminal

Pemba

- Add X-ray/security check at building entrances
- Increase size of departure lounge
- Increase size of baggage claim area
- Provide separate baggage claim for domestic arrivals & regional arrivals
- Add office area for Ministry of Tourism and Culture
- Increase sales area

Airport Rescue and Fire Fighting Facility and Airfield Maintenance Building

Nacala

- Provide eight vehicle bays to accommodate airport vehicles and equipment.

Pemba

- Increase number of vehicle bays from three to four to accommodate two foam tender vehicles, one rapid intervention vehicle (RIV), and one ambulance.

Cargo Terminal

- Provide cargo terminal with 2,660 s.m.

8.2 Preliminary Design of International Airport Facilities

Following is a narrative description of the facilities to be provided, including site work, utilities and each of the major buildings, with a brief description of the function and operational aspects of each building. The pavement design is discussed in detail in Section 7 of this report.

8.2.1 Airside Earthworks and Drainage

Excavation and Embankment

Earth works at both Pemba and Nacala will be kept to a minimum. The need for a parallel taxiway would require extensive additional earthwork at Pemba; however the addition of a new parallel taxiway is not required for the low volume of traffic projected during the design period. Therefore it has not been included it in the proposed development program.

Airfield Drainage

The natural overland flow direction at the Nacala site allows all of the airfield area east of the runway to be drained toward the southeast. Most of the area west of the runway will drain toward the west. Drainage of the site will not contribute to the overland flow into the public drinking water reservoir. The airfield drainage system will consist of open channels in infield areas and storm culverts under paved areas. The storm sewer pipes will cross under a taxiway, the passenger terminal apron and some access roads.

8.2.2 Runway, Taxiways and Aprons

The sizes of the different areas of pavement proposed for aircraft operations, namely, the runway taxiways and aprons, are based on the aircraft fleet and the peak hour operations forecast. The exception to this methodology is the length of the runway. On the basis of the fleet mix and stage length forecasts, the runway lengths were proposed to be 2,500 m in the first phase and 3,100 m in the second phase of development

Pavement Design

The type and size of aircraft expected to use the proposed International Airport ranges from the RJ-100 to the A340-200. The B737, B767, B747-100, A310 and A320 are also included as probable aircraft which will be used by carriers on the regional and international routes. The strength (thickness) of the pavement is based on the results of the preliminary study with this aircraft mix, the forecast number of operations and maximum takeoff weights (MTOW).

Visual Aids, Meteorological Equipment and Navaids

Visual aids at both Pemba and Nacala airports will consist of the following items:

- High-intensity runway edge lighting (HIRL)
- Runway end identifier lights (REILs)
- Precision approach path indicators (PAPIs), at both ends of runway
- Taxiway edge lighting (MITL)
- Runway marking in accordance with the ICAO recommendations for precision runway operations
- Taxiway marking consisting of centerline and side stripes and holding markers
- Angled marking for all paved shoulders

Meteorological Services and Equipment

The meteorological services office (met office) in the air traffic control (ATC) tower facility will provide weather observation and reporting services for the service area. Such services include monitoring weather conditions, disseminating local weather conditions and forecasts to pilots in person or by radio, communicating routinely with other national weather offices, collecting current and forecast weather data at distant airports as

requested by pilots, and administering flight plans. All activities should be conducted in accordance with national aviation weather reporting requirements and ICAO Annex 3.

Weather observers will observe, record and transmit meteorological information as required by ICAO and government standards. Observers will record sky condition, cloud cover and type, temperature, dew point, surface wind direction and speed, winds aloft direction and speed at selected altitudes, surface barometric pressure, precipitation, restrictions to visibility, and miscellaneous weather information. Observations will be made at the intervals and in the manner prescribed by the weather authorities. Local weather data should be read directly from specially manufactured and carefully calibrated weather observation instruments. Automatic recording instruments should be used to keep an accurate, permanent record of weather conditions at the airport.

Automated weather observing systems (AWOS) and automated surface observing systems (ASOS) are computerized systems that automatically observe weather conditions at an airport and report them through a synthesized human voice by way of radio or telephone. Systems are readily available from vendors and are typically programmed to respond in English; although, other languages are available.

One of the key responsibilities of aviation weather reporting services is to disseminate weather information to aircraft pilots and airline dispatchers. Weather information comes from local and distant sources. A briefing station in the weather office should be sufficient for local weather reports. Local weather data should be displayed directly and easily conveyed to the pilot, dispatcher or weather briefer. Weather information from distant areas (e.g., destination cities) must be communicated to the weather office through a national weather data center or from the many sources of weather information. A national data center is more efficient for this purpose. Local weather briefers should be able to call up, display and print weather data for any airport. Appropriate graphics (e.g., weather charts, weather radar reports and satellite photos) should be available in order to present a complete weather picture to the user or the weather service specialist.

Communication is vital for the functions of the met office. In addition to communicating with other weather offices, specialists should be able to relay weather information directly to pilots and other users. The met office; therefore, should be capable of communicating with aircraft on published aeronautical frequencies or through mode S transponder data link transmissions. Dedicated phone lines between the met office and other met offices and air traffic service facilities would ensure that information is efficiently transmitted. Local weather information should also be displayed in the tower cab to allow air traffic controllers to pass on current local weather information to pilots.

Met office specialists may also administer flight plans. This duty relieves some of the burden of air traffic controllers. After providing a weather briefing to the pilot or dispatcher, the met specialist can then accept a flight plan and relay that information to air traffic services. Departure clearances and instructions should be transmitted by air traffic controllers.

With the initiation of operations at this site, certain minimum meteorological equipment should be provided. This will include temperature/dew point gauge, anemometer, barometer, rain gauge, ceilometers, and a runway visual range transmitter and receiver.

Navaids

The International Airport should eventually be provided with a complete instrument landing system (ILS) when traffic will justify the installation. However these facilities are not included in the present proposed plans. This will include the following components:

- Outer marker
- Middle marker
- Glide slope transmitter
- Localizer transmitter

The sites for the outer and middle markers will be outside the boundaries of the airport proper. It will be necessary to provide a building or shelter having a space of approximately 10 m^2 for selected electronic equipment associated with the ILS components listed above.

ADM has indicated that there is no need at this time to install radar facilities at this site. However, the modifications and additions to the airspace plan resulting from the inauguration of this airport may require the addition of a VOR/DME at or near the airport site. The Consultant has proposed landing and takeoff procedures for the airport which are based on the use of the existing NDB presently serving the Pemba airport. At some future date, it may be necessary to install runway visual range (RVR) transmitters and receivers. This decision cannot be made at this time due to the lack of information regarding weather condition observations at the site.

8.2.3 Landside Site Works

Internal Airport Road Network and Parking Facilities

The width of the paved and stabilized area for all the internal roads will be 10 m total with 7 m of asphalt (bituminous) surface and 1.5 m stabilized shoulders on each side.

The main entrance roadway will consist of a divided roadway with an unpaved median having a total width of 23 m. The grading for all roads takes into consideration the requirements for all intersections in the preliminary design plans.

The design pavement section is constant throughout the airport and consists of the following components and thicknesses:

Bituminous surface course	5 cm
Bituminous binder course	7 cm
Base course	15 cm
Sub-base course	15 cm

The section of the entrance road serving the passenger terminal building will be configured for a continuous flow of traffic giving priority on and off the airport with a minimum of interference with other on-airport traffic. This road will also allow access from the passenger terminal to the cargo terminal. In addition, a separate road has been provided from the entrance road to the cargo terminal in order to maintain a definite separation between truck and automobile or bus traffic.

A parking area will be provided adjacent to the passenger terminal lending direct access to the departure side of the access road. This lot is designed for a capacity of 100 vehicles initially and reserved area for three hundred vehicles. Smaller parking areas are provided near the cargo terminal, airport traffic control tower facility, ARFF/AMB, as well as at the other buildings on the airport, which allow access only by airport employees.

8.2.4 Utilities

Storm Drainage

Nacala is located along a ridge where the water runs away from the airport to the east and to the west. The Nacala airport location is on a peninsula where the west side runs into the Nacala bay and the east side runs into a gully and down to a small bay of the Indian Ocean. The proposed design is integrated with the airfield drainage works described in Section 8.2.1 and consists of open channels and storm culverts under paved areas. Storm sewer pipes will cross under the passenger terminal apron and some access roads.

Water Distribution System

The water consumption is calculated to be 330 m^3/day for the peak hour passengers, visitors and employees. The water storage tank has been sized to serve this need. A water distribution network of galvanized steel pipes with diameters of 100 mm and 150 mm will provide water to all buildings.

The calculations for pipe sizes required to provide an adequate supply for firefighting is based on an assumed fire flow of 5 L/s. Fire hydrants will be located near buildings and aprons to provide ready access in a fire emergency.

Sanitary Sewer System

The sanitary sewage collection system, consisting of 200 mm diameter pipes with manholes spaced at 50 m, is designed to carry waste water from the buildings to the sewage treatment plant. Most of the system is gravity flow.

Effluent from the sewage treatment plant can be retained in an open reservoir and used to irrigate the seeded or turf grass areas, or it may be emptied directly into the existing dry stream bed without creating a pollution problem.

Electrical Distribution System

Electricity will be provided to the site by the Mozambique Electricity Corporation from an electrical main station on the highway. An electrical substation will be constructed on the airport at a site to be determined later. The primary power supply will be stepped down as necessary to provide power as needed to all airport buildings and the airfield lighting and navaid facilities. Configuration of this system can be determined when the substation site is selected.

8.2.5 Security

Site Security

A 2 m chain link security fence with a barbed-wire extension will enclose the air operations area (AOA) of the airport to deter inadvertent access by people or animals or premeditated or malicious entry by unauthorized persons. Additional barriers may be required under the fence across drainage ditches.

Authorized access to the AOA will only be possible through most airport buildings and electric or swing gates located at appropriate locations. Only authorized personnel will have access thru these points. Access can be controlled by issuing keys to those individuals who have been approved by airport management. Electric gates can be opened by a special key card, touch pad or other secure device. Storm drain inlet grates and manholes shall be bolted or locked to prevent access from points outside the Airport Operations Area other unsecured access points.

Further security will be provided on the landside to ensure segregation of the civil and military facilities by means of 3 m concrete fence along the North edge of the main access road.

Building Security

Unique characteristics of the International Airport require physical security measures for the proposed facilities. The entrances to the passenger terminal will accommodate security checks for incoming passengers, visitors and individuals having business at the terminal.

<u>X-ray Equipment</u>

Entrances for departure and arrival sectors have been concentrated in two triangular modules that provide not only specific entry and egress areas, but visual and physical control for access to the building. Each of these modules divide entry and egress functions, with entry areas containing walk-through metal detectors and X-ray units for viewing baggage, packages and other hand carried items. The departure area contains two walk-through metal detector and two X-ray units, while the arrival area contains one walk-through detector and one X-ray unit.

Prior to passenger entry for either domestic hold room or international hold room, two walk-through metal detectors and two X-ray units for carry-on baggage are provided. Cameras mounted in strategic locations, alarm contact devices, electronic locking, and card-access systems provide major elements with security for the passenger terminal and other airport buildings. For overall airport security control, photo identification cards should be required to be displayed while in secure areas.

X-ray security should be provided to the walk through to the VIP Lounge as well as any other security measures that are provided thru out the airport terminal areas. This area should not be exempt from secure security measures because it is the VIP area, but equally important it should provide the VIP visitors and tourist secure safety measures as well as the general public, travelers and the working staff of the airport.

Perimeter and Access Roadways

The section of the entrance road serving the passenger terminal building will be configured for a continuous flow of traffic giving priority on and off the airport with a minimum of interference with other on-airport traffic. This road will also allow access from the passenger terminal to the cargo terminal. In addition, a separate road has been provided from the entrance road to the cargo terminal in order to maintain a definite separation between truck and automobile or bus traffic.

A parking area will be provided adjacent to the passenger terminal lending direct access to the departure side of the access road. This lot is designed for a capacity of 100 vehicles initially and reserved area for three hundred vehicles. Smaller parking areas are provided near the cargo terminal, airport traffic control tower facility, ARFF/AMB, as well as at the other buildings on the airport, which allow access only by airport employees.

Cargo Security and Explosive Detection Equipment

As the air cargo industry continues to go through technological changes, making air cargo terminals subject to modification, it is imperative that the design approach remain flexible. As the growth develops the level of sophistication for handling air cargo is a major factor in determining the size and form of the cargo terminal. With the cargo handling techniques growing more sophisticated, the need for safety in this area of the airport can not be over looked or underestimated. A major area of security will be to have explosive detection equipment in place at the cargo terminal area.

Security and Apron Lighting and Security of Vulnerable Places

A security fence is vital for the airport where the property is inaccessible. Additional improvements are necessary to become less vulnerable by unauthorized access. New fencing will be required for any additional airport property into the airfield. A security fence should be provided along the outside edged of any property incorporated into the airfield. The outside of the airfield area should be fenced and posted to prevent

trespassers and squatters from encroaching onto the airport property.

The CAD drawings illustrate the type of fencing that is suggested for the security of the airfield and the main airport grounds including the outside perimeter. The airfield is secured with chain length fencing and the outside perimeter can be secured with barbed-wire fencing material.

For overall airport security control, photo identification cards should be required to be displayed while in secure areas.

Threshold lights should be made available the runway ends as well as the apron areas.

Isolated Aircraft Parking

With the emphasis of security taking major stage of airport operations, consideration must be give to providing an area of the airfield that can be utilized for the searching of aircraft. This would include aircraft that may be considered as a terrorist threat or may be subject to hazardous material or unlawful seizure. This area should have good access for airport staff and outside security personnel while maintaining the safety and integrity of the airport for passengers and other airport users. This area is designated on the Airport Layout Plan of the CAD drawings.

Closed circuit Television (CCTV) and Facility Access Control

Cameras mounted in strategic locations, alarm contact devices, electronic locking, and card-access systems provide major elements with security for the passenger terminal and other airport buildings.

There should be the future installation of an automatic access control system; provision should be made at the earliest stage of runway and taxiway construction for automatic access control system power supply and data transmission trenches and conduits. Similar provisions for the future installations of intrusion detection systems, electronic alarms and video and data transmission networks should also be made in terminal buildings and at vulnerable point locations. For overall airport security control, photo identification cards should be required to be displayed while in secure areas.

8.2.6 Public Communications

Basic public communications will consist of cell phones or mobile phones, pay telephone, paging and courtesy telephones located in appropriate areas of the buildings. Airport operations, maintenance, and air carrier operations will each have their own systems of ground communications equipment.

8.2.7 Furnishings

The main furnishings for the international airport facilities will consist of public seating at the passenger terminal. Built-in bench type seating is provided in the departures lobby

and the area between the domestic and international hold rooms. In addition, interior and exterior free-standing bench units are strategically located in waiting and curbside areas that do not interfere with passenger flow or processing activities.

The domestic hold room and international hold room provide seating for the comfort of passengers. This consists of tandem units of high-grade polymer resin and stainless steel with interchangeable seats and backs, to maximize length of service. Seating units have individual arm rests and are configured to allow adequate access throughout the hold room. The domestic hold room contains approximately 150 units and the International hold room approximately 200 units.

Public seating in other buildings consists of individual units appropriate to the use and location. Office and administrative furnishings consisting of desks, chairs, tables, credenzas and cases or shelving units are selected for the appropriate use and location.

Public area tenant improvement furnishings and fittings are selected for the appropriate use in keeping with airport standards established by the overall design guidelines.

8.3 Building Architectural Design

8.3.1 Conceptual Construction Schedule

The demand/capacity analysis for the architectural design basis of the following four buildings at Nacala are discussed in Section 7 of this report.

- International Terminal Building
- Airport Traffic Control Tower Facility
- Airport Rescue and Fire Fighting Facility/Airfield Maintenance Building
- Cargo Terminal

The construction schedule indicates that a time frame of 36 months is adequate for completion of the first phase of construction of this project consisting of site work, utilities, terminal building, ARFF/airfield maintenance building and cargo terminal. However the ARFF/airfield maintenance building and cargo terminal can be delayed for the first five years of operation. These facilities can be constructed in stages as the demand for services increases. This estimate of time is based on the needs and requirements associated with the actual construction effort and the lead time required for delivery of selected manufactured items necessary for operation of the airport as a complete entity.

8.3.2 International Passenger Terminal

Two alternative designs were selected for the new Nacala international airport passenger terminal building as part of the Berger study in 2004. One alternative is based on

Mozambique's native housing unit design and the second is a modern architectural design. Both alternative building types are required to be hurricane/cyclone-resistant concrete construction. Both designs also incorporate natural flow-through air ventilation. The primary consideration for the initial phase is to protect passengers and luggage from the weather until more extensive accommodations can be provided as the volume of air traffic increases. Tourists are coming for the sun, water and beach and are not looking for a deluxe airport facility. Therefore, we recommend that some amenities be delayed until passenger flows can support those improvements.

The ultimate passenger terminal development is designed as a single-level, linear concept of 8,924 m^2 with centralized terminal functions. Based on the recommendation for a new passenger terminal building at Nacala airport, a conceptual cost estimate has been prepared to provide a one-level facility measuring approximately 4,000 m^2, for the initial phase of the development.

The landside portion of the building contains major passenger processing activities, waiting areas and amenities for users of the terminal. The airside portion contains passenger holding areas and amenities, baggage claim areas, customs and immigration facilities and air carrier operations areas.

The main landside entry to the passenger terminal for departing passengers is through the departures vestibule and building security at the ticketing lobby. This area of the building contains passenger ticketing/check-in, airline offices, baggage make-up, and air carrier operations. Initially, 10 ticket counter positions will be provided and space available and dedicated for future expansion. Horizontal expansion of this area may be accomplished by the addition of modular building structure units.

From this area, passengers and public users will circulate past concessions, chapel or serenity room and restaurant toward the departures lobby and air carrier security for entry to the domestic hold room or emigration and the international hold room. Access to the duty free shop is from the international hold room. Other amenities in this area of the passenger terminal include police, doctor/dispensary, nursery and public toilets with access from secure and non-secure sections of the terminal. Storage, trash, and electrical rooms are in this area.

The arrivals portion of the passenger terminal contains the domestic baggage claim area with two claim devices, air carrier baggage service offices and baggage drop-off area. The domestic and international arrivals lobby serves as waiting areas for reception and greeters who enter the passenger terminal at the arrivals vestibule and building security. Rental car and ground transportation services are in this area, as well as concessions, public toilets, currency exchange, tourist bureau, offices for the Ministry of Tourism and Culture and the airport administration. An in-transit lounge with toilets and an area for concessions, including food and beverage, is located in this section of the terminal. The passenger terminal main electrical room is in this area of the building, while heating and cooling units are roof-mounted in equipment wells above this area and other locations on the roof.

The international arrivals area is a separate, self-contained and secure zone of the passenger terminal. International arriving passengers enter the facility from the airside and are processed through immigration, which contains offices and health services, including quarantine and laboratory facilities. One baggage claim device is provided in the international baggage claim area, which is served by the baggage drop-off area. The customs area continues the processing activities of passengers and contains inspection counters, offices, public toilets and cashier. This area provides access into the international arrivals lobby on the landside.

A diplomatic/VIP lounge with private ingress and egress completes this area of the passenger terminal. The VIP lounge contains separate landside and airside entries, security, offices, waiting area, toilets and a pressroom.

Expansion of the domestic baggage claim area can be accomplished by two methods. An initial approach could combine utilization of the claim device assigned to the international baggage claim area with the addition of security gates to prohibit passenger flow into immigration and customs areas. A similar security partition could be used to separate the claim areas when international arriving passengers are claiming bags and being processed. Long term major expansion of baggage claim area, immigration, customs and the diplomatic VIP lounge would involve relocation by the simple addition of additional modules to the left of the proposed facility.

The international holding room can be expanded by utilizing space assigned to the in-transit lounge, thus increasing the holding room area by approximately 100%.

An air carrier CIP lounge can be located on Level 2 above air carrier security. Access to the CIP lounge is by stairs located in the circulation area between domestic and international hold rooms.

The passenger terminal is designed structurally to accommodate a second level above the center portion of the building. Stair towers near the departures lobby would provide access to this level, which could contain administrative, concession and support services functions. A two-story open area above the departures lobby provides visual enhancement and dramatic effect.

Landside access to the passenger terminal is from the main roadway system, which provides curbside drop-off and pick-up areas for private and commercial vehicles, entrance and exit for an on-grade parking area, and a return-to-terminal loop or airport exit for vehicular movements.

PASSENGER TERMINAL SPACE PROGRAM SUMMARY

Level 1		
Departures lobby		352 m^2
Ticketing/check-in		456 m^2
Ticket counter positions-	10	
Ticket counter area	114 m^2	
ATO area	130 m^2	
Ticket area/queuing	212 m^2	
Baggage make-up area		375 m^2
Air carrier operations		212 m^2
OPS area	140 m^2	
Toilets/showers/lockers	72 m^2	
Building security (police)		420 m^2
Check points	346 m^2	
Office area	74 m^2	
Reception		
Private offices (2)		
Holding cell		
Air carrier security		120 m^2
Security devices (2)		
Search rooms		
Emigration		130 m^2
Inspection counters		
Offices		
In-transit lounge		132 m^2
Departure hold rooms		712 m^2
Domestic	490 m^2	
International	222 m^2	
Special passenger services		518 m^2
Mescit/chapel	80 m^2	
Nursery	33 m^2	
Doctor/dispensary	16 m^2	
Lab	12 m^2	
Flight information	6 m^2	
Currency exchange	23 m^2	
VIP lounge	348 m^2	
Baggage claim - domestic		640 m^2
Baggage services offices		48 m^2
Baggage drop-off		456 m^2
Arrivals lobby (domestic + international)		638 m^2
Rental car and ground transportation/offices		50 m^2
Retail concessions/duty free		592 m^2
Toilets		378 m^2
Building maintenance/trash/storage		92 m^2
Electrical		94 m^2
Administration		202 m^2
Reception/waiting	30 m^2	
Offices	78 m^2	
Ministry of Tourism and Culture	38 m^2	
Circulation	20 m^2	

Tourist bureau	36 m^2	
Immigration		346 m^2
Lobby/queuing	134 m^2	
Offices	58 m^2	
Secondary inspection	20 m^2	
Health services	56 m^2	
Inspection/circulation	78 m^2	
Baggage claim - international		324 m^2
Customs		362 m^2
Queuing/inspection counters	140 m^2	
Toilets	56 m^2	
Offices/search rooms	40 m^2	
Agriculture	24 m^2	
Cashier	18 m^2	
Circulation	84 m^2	
Circulation		1115 m^2
Level 1 Total:		**8,764 m^2**
Level 2		
Air carrier CIP lounge		110 m^2
Circulation		50 m^2
Level 2 Total:		**160 m^2**
Total Program:		**8,924 m^2**

8.3.3 Airport Traffic Control Tower Facility

An air traffic control tower facility exists at Pemba airport and appears to be adequate for operations at the airport for the foreseeable future. Therefore, the proposed development program at Pemba does not include any improvements or expansion of the air traffic control facilities.

At Nacala, the adequacy of the existing abandoned ATC tower cannot be confirmed in terms of its structural integrity and proper height of observation vis-à-vis the extended airfield area. In any event, the current state of the structure is such that new exterior glazing, interior furnishings and control tower equipment would have to be installed throughout the building and, in particular, in the cab of the control tower. The ground floor of the building is suitable for an equipment room that can house electrical power support. Only the new equipment is included in the investment program.

Alternatively, a new control tower design is included for future use should the existing control tower prove to be inadequate. The ATC building consists of 1,312 m^2 on two main levels and a control tower with cab for monitoring airport activity.

At 648 m^2, Level 1 contains the main landside entry vestibule and lobby. Work areas for ATC/equipment, meteorological room, briefing room and staff offices comprise the majority of space on this level. Toilets and major building mechanical and electrical spaces are on this level.

Access to the 540 m^2 Level 2 is via the elevator or stair vertical circulation core. Operational/staff offices and related work areas for AFTN, ATC and voice recorder are located on this level. The controller rest area, toilets and Uninterrupted Power Supply room complete the facilities on Level 2.

The proposed Nacala control tower will function as a combined aerodrome and approach service without radar. The control tower cab level will provide space for a low level of operations, with 6 personnel and a floor area of 21 m^2. It will include the following initial positions:

- 1 aerodrome control position
- 1 approach control position
- 1 ground control position
- 1 vacant position for future services and/or observation by military personnel

Service access to the control tower and cab is via an elevator and stairway in a vertical circulation core. An exterior walkway at the cab level will enable window-washing and repairs and maintenance.

Landside vehicular access to the ATC building is from the airport main roadway system. The building has a general pedestrian entry on the landside, or non-secure, area of the airport. Other entrances are controlled, secure and provide access to authorized individuals only.

It is not anticipated that this facility will require expansion under current or forecast operational characteristics.

AIRPORT TRAFFIC CONTROL TOWER FACILITY SPACE PROGRAM SUMMARY

Level 1		
Vestibule/lobby		150 m^2
Work areas		266 m^2
Briefing room	36 m^2	
Meteorological room	58 m^2	
ATC equipment room	144 m^2	
Chief	18 m^2	
Equipment maintenance	10 m^2	
Toilets		52 m^2
Building maintenance		6 m^2
Mechanical/electrical		70 m^2
Circulation corridors, elevators, stair		104 m^2
Level 1 Total:		**648 m^2**
Level 2		
Lobby		36 m^2
Office areas		94 m^2
Director		36 m^2
Assistant director		28 m^2

Staff	20 m^2
Circulation	10 m^2
Work Areas	230 m^2
AFTN	36 m^2
ATC	36 m^2
Voice recorder	36 m^2
Controller rest area	54 m^2
ATC supervisor	18 m^2
Equipment maintenance	26 m^2
Circulation	24 m^2
Toilets	52 m^2
Building maintenance	6 m^2
Mechanical/electrical	24 m^2
Circulation, incl. corridors, elevator, stairs)	98 m^2
Level 2 Total	**540 m^2**
Level 3	
Circulation	36 m^2
Level 3 Total	**36 m^2**
Level 4	
Circulation	36 m^2
Level 4 Total	**36 m^2**
Level 5	
Equipment room and circulation	36 m^2
Level 5 Total	**36 m^2**
Level 6	
Control tower cab and circulation	36 m^2
Level 6 Total	**36 m^2**
Total Program	**1,332 m^2**

8.3.4 Airport Rescue and Fire Fighting Facility/Airfield Maintenance Building

The ARFF/airfield maintenance building is a 1,980 m^2 combined, single-level facility with a shared lobby area and high ceiling bays for storage and maintenance of required vehicles.

The 924 m^2 ARFF portion contains four large bays for high profile vehicles required to respond to emergencies or disasters that may occur at the airport. Support areas consist of office and operational spaces, a training/meeting room, a dormitory that can serve as a command center or larger first aid facility in the event of a major emergency, toilet/shower/locker room, and needed storage, mechanical and electrical spaces.

The 968 m^2 airfield maintenance building contains eight high ceiling bays for storage and routine maintenance and repair of a variety of vehicles and equipment regularly utilized at the airport. Areas for offices, cart storage, toilet facilities and mechanical room complete this area.

A vestibule/lobby area of 88 m^2 provides common use access to this facility.

Landside vehicular access to this building is from the airport main roadway system. The building is entered through the landside as a non-secure area of the airport. All vehicles leave and return to the building from the airside, or secure side, of the airport.

Required expansion to vehicular bays would be in a linear configuration.

AIRPORT RESCUE AND FIRE FIGHTING FACILITY/AIRFIELD MAINTENANCE BUILDING/SPACE PROGRAM SUMMARY

Common Area		
Vestibule/lobby		**88 m²**
ARFF		
Office area		82 m²
Watch room	26 m²	
First Aid	14 m²	
Director	14 m²	
Office	14 m²	
Office	14 m²	
Training room total		145 m²
Kitchen	8 m²	
Toilet	7 m²	
Training room	130 m²	
Dormitory		106 m²
Toilets/showers/lockers		54 m²
Vehicle bays		360 m²
Storage		55 m²
Mechanical/electrical		60 m²
Circulation		62 m²
ARFF Total		**924 m²**
AMB		
Office area		78 m²
Toilets		46 m²
Building maintenance		3 m²
Vehicle bays		684 m²
Parts storage		48 m²
Mechanical/electrical		24 m²
Circulation		85 m²
AMB Total		**968 m²**
Total Program		**1,980 m²**

8.3.5 Cargo Terminal

The cargo terminal is 3,690 m² with high bay cargo storage and processing areas and a two-level controlled access and service area, with additional space for secure storage and office area for agents, inspectors and support personnel.

The cargo bays are designed with sufficient height to accommodate technology changes in the industry, allow for growth and provide for various techniques and degrees of

mechanization to be utilized.

Major areas within the cargo bays related to processing activities included import, export, domestic and cold storage functions.

Level 1 of the building core at 630 m^2 contains document processing activities, additional space for secure storage, testing lab, morgue, toilets and lounge area and building mechanical and electrical rooms.

Level 2 also at 630 m^2 is accessed by stairs and contains offices for customs agents, administration and for cargo agents involved in processing activities. Toilets and a lounge area complete major spaces on this level.

Landside vehicular access to the cargo terminal is from the airport roadway system. Loading docks are provided on the landside for cargo loading and unloading with direct access to the apron area from cargo bays for loading and unloading aircraft.

Expansion of the cargo terminal would be achieved in a linear manner by adding appropriate cargo bays.

CARGO TERMINAL SPACE PROGRAM SUMMARY

Level 1		
Office area		137 m^2
Lobby	52 m^2	
Documents	20 m^2	
Cashier	9 m^2	
Accounts	14 m^2	
Lounge	42 m^2	
Toilets		35 m^2
Building maintenance		6 m^2
Testing lab		34 m^2
Storage		188 m^2
Morgue		22 m^2
Mechanical/electrical		44 m^2
Circulation		
Corridors, stairs		164 m^2
Import		540 m^2
Export		1080 m^2
Cold storage		540 m^2
Domestic		270 m^2
Level 1 Total		**3060 m^2**
Level 2		
Lobby/reception		94 m^2
Office area		334 m^2
Customs manager	60 m^2	
Accounting	45 m^2	
Cargo agents	54 m^2	
Administration	34 m^2	
Files	66 m^2	
Lounge	45 m^2	
Toilets		35 m^2
Building maintenance		7 m^2
Circulation corridors, stairs		160 m^2
Level 2 Total		**630 m^2**
Total Program:		**3690 m^2**

8.3.6 Codes and Standards

U.S. FAA, ICAO and Mozambique standards are utilized to establish design criteria for the International Airport.

General Building Codes

- Uniform Building Code, current edition
- Life Safety Code, NFPA 101, current edition
- American National Standard Specifications ANSI A117.1
- Building Code Requirement, TS 500

Standards

- International Air Transport Association, Airport Terminals Reference Manual, 8th edition, January 1994
- International Civil Aviation Organization, International Standards and Recommended Practices, Aerodromes, Annex 14, Second Edition, July 1995
- Guidelines for Airport Signing and Graphics, Second Edition, July 1994

Reports

- Initial Inception Report for Development of New International Airport

Structural

- American Concrete Institute, Building Code Requirements for Reinforced Concrete, ACI 318-89m (revised 1992).
- American Institute of Steel Construction Manual of Steel Construction, Allowable Stress Design, current edition
- ASCE Standard, Minimum Design Loads for Buildings and Other Structures, ANSI/ASCE 7-93.
- Design loads for buildings and other structures, TS 498
- Building Code for Steel Structures, TS 648

Mechanical

- BOCA Mechanical Code, current edition
- BOCA Plumbing Code, current edition
- Principles for Preparation of the Projects of the Central Heating System, TS2164
- Thermal Insulation in Buildings, TS 825
- Water Supply System for Premises, Specifications for Construction, TS 828
- Rules for Design and Settlement of Chimneys, TS 2165
- Sizing Water Supply Systems for Premises, TS 1258
- Natural Gas, Principles of Projects and Applications of Installation in Buildings, TS 7363
- Principles for the Preparation of the Preparation of the Projects of Ventilation and Air Conditioning Installation, TS 3419

Fire Protection

- Sprinkler Systems, NFPA 13, current edition
- Standard on Construction and Protection of Airport Terminal Buildings, NFPA 416, 1993 Edition

Electrical

- National Electrical Code, current edition.
- Specification for Electrical works

- (Published by Ministry of Public works and Housing)
- (Published by Mozambique Electrical Authority)

Sitework

- International Civil Aviation Organization, International Standards and Recommended Practices, Aerodromes, Annex 14, Second Edition, July 1995
- International Civil Aviation Organization, Aerodrome Design Manual - Doc. 9157-AN/901, Part 1 - Runways
- International Civil Aviation Organization, Aerodrome Design Manual - Doc. 9157-AN/901, Part 2 - Taxiways, Aprons and Holding Bays
- International Civil Aviation Organization, Aerodrome Design Manual - Doc. 9157-AN/901, Part 3 - Pavements
- International Civil Aviation Organization, Aerodrome Design Manual - Doc. 9157-AN/901, Part 4 - Visual Aids
- International Civil Aviation Organization, Aerodrome Design Manual - Doc. 9157-AN/901, Part 5 - Electrical Systems
- FAA AC 150/5300-13, Airport Design
- FAA AC 150/5320-5B, Airport Drainage
- FAA AC 150/5320-6D, Airport Pavement Design and Evaluations
- FAA AC 150/5325-4A, Runway Length Requirements for Airport Design
- FAA AC 150/5340-18C, Standards for Airport Sign Systems
- FAA AC 150/5340-24, Runway and Taxiway Edge Lighting System
- FAA AC 150/5345-28D, Precision Approach Path Indicator (PAPI) Systems
- Specifications for Road Construction (published by Ministry of Public Works and Housing)
- Technical Specifications for Support Construction (published by DLH)

8.4 AutoCAD Drawings Index

The drawings in AutoCAD format are listed below and physically appear in a separate Appendix which forms part of the present Final Report. They are listed as follows for Nacala and Pemba airports:

Nacala International Airport

Airport Layout Plan	AA ALP 01
Terminal Area Plan	AA TAP 01
Terminal Floor Plan Arrival & Departure	NT 02
Arrival Area Floor Plan	NT 02A
Departure Area	NT 02D
Terminal Sections A-B-C-D	NT 03
Terminal Sections E-F-G	NT 04
Departure Area Floor Plan with Dimensions	NT 05
Arrival Area Floor Plan with Dimensions	NT 06
Terminal Elevations	NT 07
Terminal Elevations	
NT 08	
Reflective Ceiling Plan	NT 09
Terminal Floor Plan Passenger Path	NT 10
Lighting Plan Arrival Area	EA 01
Lighting Plan Departure Area	EA 02
Terminal Power Plan Arrival Area	EA 03
Terminal Power Plan Departure Area	EA 04
Omitted	EA 05
Omitted	EA 06
Power – One Line Riser Diagram	EA 07
Equipment Layout Plan & Power Distribution Plan	EA 08
Terminal Mechanical Plan Arrival Area	MA 01
Terminal Mechanical Plan Arrival Area	MA 02
Structural Notes	SA 01
Terminal Foundation Plan Arrival Area	SA 02
Terminal Foundation Plan Departure Area	SA 03
Terminal Framing Plan Arrival Area	SA 04
Terminal Framing Plan Departure Area	SA 05
Terminal Framing Plan Second Floor	SA 06
Terminal Framing Details Column Schedule	SA 07
ARFF & AFM Floor Plan	ARFF 01
ARFF & AFM Floor Plan Sector A	ARFF 02
ARFF & AFM Floor Plan Sector B	ARFF 03
ARFF & AFM Elevations	ARFF 04
ARFF & AFM Section 'C'	ARFF 05
ARFF & AFM Section 'B'	ARFF 06
ARFF & AFM Section 'A'	ARFF 07
ATC Building Floor Plans 1 & 2	ATC 01

ATC Building Floor Plans 3-4-5 & 6	ATC 02
ATC Building Front Elevation	ATC 03
ATC Building Back Elevation	ATC 04
ATC Building Side Elevation	ATC 05
ATC Building Cross Sections	ATC 06
Cargo Building Floor Plan Level 1	C 01
Cargo Building Floor Plan Level 2	C 02
Cargo Building Elevations	C 03
Cargo Building Sections	C 04
Cargo Building Section A	C 05
Cargo Building Section B	C 06
Cargo Building Section C	C 07

Pemba Airport

Pemba Passenger Terminal Expansion-Phase One	AA01-P1
Pemba Passenger Terminal Expansion-Phase Two	AA01-P2
Airport Layout Plan	AA01-P3
Terminal Area Plan	AA01-P4

APPENDIX A :

Cost Construction Estimates for Nacala Airport

Appendix A

Cost Estimates

ITEM #	PERIOD 1 (2009-2013)- Projects to be Completed Before 2014	Investments from Operations	Investments from Others or Delayed	Finalization Date	USA %	US Imports	Ex-Im Bank	AFDB Financing
	Airside	**$1,841,665**	**$4,275,000**			**$184,167**	**$156,542**	**$1,685,123**
P1-1	Runway and one Taxilane rehabilitation	$1,550,000	$0	By the end of 2009	10	$155,000	$131,750	$1,418,250
P1-2	Apron area upgrade for two stands	$291,665	$0	By the end of 2010	10	$29,167	$24,792	$266,873
P1-3	Perimeter Fence and Road	$0	$775,000	By the end of 2013	60	$0	$0	$0
P1-A	Complete construction and bid documents	$0	$3,500,000	By the end of 2008	85	$0	$0	$0
	Navigational Aids	**$284,000**	**$0**			**$210,000**	**$178,500**	**$105,500**
P1-4	Control Tower Upgrade with new console & Equipment	$172,000	$0	By the and Of 2009	85	$146,200	$124,270	$47,730
P1-5	Runway Marking and Signage system	$45,000	$0	By the end of 2009	58	$26,100	$22,185	$22,815
P1-6	Wind cone and lightening systems of the airport	$55,000	$0	By the end of 2009	50	$27,500	$23,375	$31,625
P1-7	Guidance system to utilize GPS by WAAS or SBAS	$12,000	$0	By the end of 2009	85	$10,200	$8,670	$3,330
P1-8	Automatic Information System	$0	$0	By the end of 2009	85	$0	$0	$0
P1-9	Control Screen for Air Traffic Control	$0	$0	By the end of 2009	85	$0	$0	$0
	General Aviation Infrastructure	**$0**	**$1,972,045**			**$0**	**$0**	**$0**
P1-10	Hangar - Additional required area	$0	$884,000	By the end of 2009	50	$0	$0	$0
P1-11	Hangar Apron - Additional required area	$0	$3,802	By the end of 2009	10	$0	$0	$0
P1-12	Apron for transit flights - Additional required area	$0	$594,272	By the end of 2009	10	$0	$0	$0
P1-13	Rehabilitate Apron for transit flights and based aircraft	$0	$489,971	By the end of 2009	10	$0	$0	$0
	Auxiliary Facilities	**$275,000**	**$358,235**			**$221,000**	**$187,850**	**$87,150**
P1-14	Rehabilitate Apron for commercial flights	$0	$0	By the end of 2009	10	$0	$0	$0
P1-15	ARFF: Acquire Vehicles	$25,000	$0	By the end of 2009	85	$21,250	$18,063	$6,938
P1-16	ARFF: New protecting equipment for firefighters	$20,000	$0	By the end of 2009	85	$17,000	$14,450	$5,550
P1-17	ARFF: Rehabilitate existing building	$65,000	$0	By the end of 2009	85	$55,250	$46,963	$18,038
P1-18	ARFF: Category 9 equipment	$80,000	$0	By the end of 2009	85	$68,000	$57,800	$22,200
P1-19	Storage Capacity for Jet A	$0	$358,235	By the end of 2009	70	$0	$0	$0
P1-20	Storage Capacity for AvGas	$0	$890,120	By the end of 2009	70	$0	$0	$0
P1-21	Security: Acquire equipment, signalization, ID badges system	$0	$0	By the end of 2009	60	$0	$0	$0
P1-22	Apron equipment (11 pieces per position)	$85,000	$0	By the end of 2009	70	$59,500	$50,575	$34,425
	Passenger Terminal Facilies	**$2,382,970**	**$0**			**$1,089,985**	**$926,487**	**$1,456,483**
P1-23	Terminal Building	$1,500,000	$0	By the end of 2010	30	$450,000	$382,500	$1,117,500
P1-24	Ticketing Counters	$77,970	$0	By the end of 2010	50	$38,985	$33,137	$44,833
P1-25	Handling Luggage System	$55,000	$0	By the end of 2010	70	$38,500	$32,725	$22,275
P1-26	FIDS	$0	$0	By the end of 2010	75	$0	$0	$0
P1-27	CCTV	$0	$0	By the end of 2010	75	$0	$0	$0
P1-28	Security Equipment X-Rays	$750,000	$0	By the end of 2010	75	$562,500	$478,125	$271,875
	Landside and Site development Facilities	**$1,902,375**	**$1,174,000**			**$1,035,863**	**$880,483**	**$1,021,892**
P1-29	Acquisions of the airport by ADM	$0	$0	By the end of 2008	0	$0	$0	$0
P1-30	Land Acquisition Grading	$85,000	$0	By the end of 2010	10	$8,500	$7,225	$77,775
P1-31	Storm Drainage	$93,750	$365,000	By the end of 2009	70	$65,625	$55,781	$37,969
P1-32	Sewerage treatment plant and collection system	$234,375	$0	By the end of 2010	70	$164,063	$139,453	$94,922
P1-33	Water distribution	$156,250	$0	By the end of 2010	70	$109,375	$92,969	$63,281
P1-34	General Electrical Works	$750,000	$250,000	By the end of 2010	70	$525,000	$446,250	$303,750
P1-35	Water Storage Tank	$175,000	$59,000	By the end of 2010	70	$122,500	$104,125	$70,875
P1-36	Water supply Line off site	$125,000	$500,000	By the end of 2010	10	$12,500	$10,625	$114,375
P1-37	Access Road from Highway to terminal Parking	$158,000	$0	By the end of 2010	10	$15,800	$13,430	$144,570
P1-38	Landside Parking Facilities	$125,000	$0	By the end of 2013	10	$12,500	$10,625	$114,375
	Air Cargo Terminal and Customs Facilities	**$0**	**$1,930,000**			**$0**	**$0**	**$0**
P1-39	Cargo Terminal	$0	$1,930,000	By the end of 2012		$0	$0	$0
	Subtotal	**$6,686,010**	**$9,709,280**	**$16,395,290**		**$2,741,014**	**$2,329,862**	**$4,356,148**

Appendix A

Cost Estimates

ITEM #	PERIOD 2 (2014-2018) - Projects to be Completed Before 2015	Investments from Operations	Investments from Others or Delayed	Finalization Date	USA %	US Funds	Ex-IM Bank	ADB Financing
	Airside	**$4,656,949**	**$1,262,000**			**$1,108,195**	**$941,966**	**$3,714,983**
P2-1	Internal Roads	$250,000	$1,262,000	By the end of 2018	10	$25,000	$21,250	$228,750
P2-2	Increase pavement capacity to the runway 57/F/C/X/T	$1,332,000	$0	By the end of 2018	10	$133,200	$113,220	$1,218,780
P2-3	Apron area expansion and upgrade for 3 additional Stands	$650,000	$0	By the end of 2018	10	$65,000	$55,250	$594,750
P2-4	Install oil seperators in ramp area to prevent spillage pollution	$150,000	$0	By the end of 2018	30	$45,000	$38,250	$111,750
P2-5	Install Apron Lighting	$875,000	$0	By the end of 2018	80	$700,000	$595,000	$280,000
P2-6	Increase pavement capacity to the taxiway system 57/F/C/X/T/	$1,399,949	$0	By the end of 2018	10	$139,995	$118,995	$1,280,959
	Navigation Aids	**$275,000**	**$0**			**$233,750**	**$198,688**	**$76,313**
P2-7	Additional Control tower communication equipment	$275,000	$0	By the end of 2018	85	$233,750	$198,688	$76,313
P2-8	PEILs	$0	$0	By the end of 2018	85	$0	$0	$0
	General Aviation Infrastructure	**$0**	**$1,419,411**			**$0**	**$0**	**$0**
P2-9	Hangar- Additional required area	$0	$576,000	By the end of 2018	50	$0	$0	$0
P2-10	Hangar Apron- Additional required area	$0	$79,366	By the end of 2018	10	$0	$0	$0
P2-11	Apron for transit flights - Additional required area	$0	$603,895	By the end of 2018	10	$0	$0	$0
P2-12	Expand GA Building	$0	$160,150	By the end of 2018	50	$0	$0	$0
	Auxiliary Facilities	**$2,679,737**	**$3,298,683**			**$431,724**	**$366,965**	**$3,332,772**
P2-13	Expand Commercial Apron	$1,349,789	$0	By the end of 2018	10	$134,979	$114,732	$1,215,057
P2-14	Increase pavement capacity to the commercial apron 57/F/C/X/T	$2,049,948	$0	By the end of 2018	10	$204,995	$174,246	$1,875,702
P2-15	Expansion of maintenance and storage facilities	$85,000	$0	By the end of 2018	10	$8,500	$7,225	$77,775
P2-16	ARFF: Building Expansion	$110,000	$0	By the end of 2018	10	$11,000	$9,350	$100,650
P2-17	ARFF: New Equipment for Category 9	$0	$0	By the end of 2018	85	$0	$0	$0
P2-18	Expand Storage Capacity for Jet A	$0	$1,076,933	By the end of 2018	70	$0	$0	$0
P2-19	Expand Storage Capacity for AvGas	$0	$757,070	By the end of 2018	70	$0	$0	$0
P2-20	Catering Facilities	$0	$569,680	By the end of 2018	10	$0	$0	$0
P2-21	Ramp equipment (11 pieces per position)	$85,000	$0		85	$72,250	$61,413	$23,588
P2-22	Incinerator	$0	$381,000	By the end of 2018	80	$0	$0	$0
P2-23	Triturator	$0	$357,000	By the end of 2018	80	$0	$0	$0
P2-24	Plant and Animal inspection	$0	$157,000	By the end of 2018	10	$0	$0	$0
	Passenger Terminal Facilities	**$2,170,000**	**$0**			**$812,000**	**$690,200**	**$1,479,800**
P2-25	Terminal Building extension	$1,500,000	$0	By the end of 2018	30	$450,000	$382,500	$1,117,500
P2-26	Ticketing Counters	$550,000	$0	By the end of 2018	50	$275,000	$233,750	$316,250
P2-27	Handling Luggage System	$60,000	$0	By the end of 2018	70	$42,000	$35,700	$24,300
P2-28	FIDS	$25,000	$0	By the end of 2018	75	$18,750	$15,938	$9,063
P2-29	CCTV	$35,000	$0	By the end of 2018	75	$26,250	$22,313	$12,688
	Land side and Site Development Facilities	**$0**	**$6,500,000**			**$0**	**$0**	**$0**
	Industrial park development and access road ancillary services	$0	$6,500,000	By the end of 2018	15	$0	$0	$0
P2-30	Land side Parking Facilities Expansion		$0	By the end of 2018	10	$0	$0	$0
	Al. Cargo Terminal Facilities	**$0**	**$1,250,000**			**$0**	**$0**	**$0**
P2-31	Cargo Terminal and Customs Facilities Expansion	$0	$1,250,000	By the end of 2018	15	$0	$0	$0
	Subtotal	**$10,781,686**	**$13,730,094**		**$24,511,780**	**$2,585,658**	**$2,197,818**	**$8,583,868**

Appendix A

Cost Estimates

ITEM#	PERIOD 3 (2019-2023): Projects to be Completed Before 2024	Investments from Operations	Investments from Others or Delayed	Finalization Date		US Imports	Exim Bank	ADB Financing
	Airside	**$0**	**$0**			**$0**	**$0**	**$0**
P2-1	Runway Extension	$0	$0	By the end of 2023	10	$0	$0	$0
		$0	$0	By the end of 2023	10	$0	$0	$0
	Navigational Aide	**$0**	**$0**	By the end of 2023		**$0**	**$0**	**$0**
P3-2	Control Tower Upgrade with new console & Equipment	$0	$0	By the end of 2023	85	$0	$0	$0
P3-3	Update to signage system	$0	$0	By the end of 2023	58	$0	$0	$0
P3-4	Runway lighting and lighting of one taxiway	$0	$0	By the end of 2023	58	$0	$0	$0
	General Aviation Infrastructure	**$0**	**$3,124,151**			**$0**	**$0**	**$0**
P3-5	Hangar - Additional required area	$0	$1,476,000	By the end of 2023	50	$0	$0	$0
P3-6	Hangar Apron - Additional required area	$0	$199,870	By the end of 2023	10	$0	$0	$0
P3-7	Apron for transit flights - Additional required area	$0	$1,181,361	By the end of 2023	10	$0	$0	$0
P3-8	Expand GA Building	$0	$266,920	By the end of 2023	10	$0	$0	$0
	Auxiliary Facilities	**$1,585,000**	**$2,551,016**			**$158,500**	**$134,725**	**$1,450,275**
P3-9	New Control Tower	$0	$0	By the end of 2023	35	$0	$0	$0
P3-10	Expand Commercial Apron	$1,500,000	$0	By the end of 2023	10	$150,000	$127,500	$1,372,500
P3-11	Expansion of maintenance and storage facilities	$85,000	$0	By the end of 2023	10	$8,500	$7,225	$77,775
P3-12	Expand Storage Capacity for Jet A	$0	$688,815	By the end of 2023	70	$0	$0	$0
P3-13	Expand Storage Capacity for AvGas	$0	$1,537,701	By the end of 2023	70	$0	$0	$0
P3-14	Catering facilities	$0	$324,500	By the end of 2023	30	$0	$0	$0
	Passenger Terminal Facilities	**$3,506,000**	**$0**			**$1,637,750**	**$1,392,088**	**$2,113,913**
P3-15	Terminal Building extension	$1,500,000	$0	By the end of 2023	10	$150,000	$127,500	$1,372,500
P3-16	Ticketing Counters	$55,000	$0	By the end of 2023	50	$27,500	$23,375	$31,625
P3-17	Luggage Handling System	$60,000	$0	By the end of 2023	70	$42,000	$35,700	$24,300
P3-18	FIDS	$65,000	$0	By the end of 2023	75	$48,750	$41,438	$23,563
P3-19	CCTV	$45,000	$0	By the end of 2023	75	$33,750	$28,688	$16,313
P3-20	Security Equipment X-Rays	$1,781,000	$0	By the end of 2023	75	$1,335,750	$1,135,388	$645,613
	Land side and Site Development Facilities	**$0**	**$1,599,227**			**$0**	**$0**	**$0**
P3-21	Curbside Extension	$0	$0	By the end of 2023	10	$0	$0	$0
P3-22	Landside Parking Facilities Expansion	$0	$1,599,227	By the end of 2023	10	$0	$0	$0
	Air Cargo and Customs Terminal Facilities	**$0**	**$850,000**			**$0**	**$0**	**$0**
P3-23	Cargo Terminal Expansion	$0	$850,000	By the end of 2023	10	$0	$0	$0
	Subtotal	**$5,091,000**	**$8,124,394**		**$13,215,394**	**$1,796,250**	**$1,526,813**	**$3,564,188**

Appendix A

Cost Estimates

ITEM #	PERIOD 4 (2024-2028) - Projects to be Completed Before 2029	investments from Operations	Investments from Others or Delayed	Finalization Date		US Imports	Ex-Im Bank	ADB Financing
	Airside	**$1,500,000**	**$0**			**$150,000**	**$127,500**	**$1,372,500**
P4-1	Runway blast pads	$0	$0	By the end of 2028	10	$0	$0	$0
P4-2	Upgrade portion of Taxiway and two exits to the runway	$1,500,000	$0	By the end of 2028	10	$150,000	$127,500	$1,372,500
	Navigational Aide	**$75,000**	**$0**			**$63,750**	**$54,188**	**$20,813**
P4-3	Control Tower Upgrade with new console & Equipment	$75,000	$0	By the end of 2028	85	$63,750	$54,188	$20,813
P4-4	Update to signage system	$0	$0	By the end of 2028	58	$0	$0	$0
P4-5	REILS	$0	$0	By the end of 2028	70	$0	$0	$0
	General Aviation Infrastructure	**$0**	**$3,496,537**			**$0**	**$0**	**$0**
P4-6	Hangar - Additional required area	$0	$1,728,000	By the end of 2028	50	$0	$0	$0
P4-7	Hangar Apron - Additional required area	$0	$233,656	By the end of 2028	10	$0	$0	$0
P4-8	Apron for transit nights - Additional required area	$0	$1,267,961	By the end of 2028	10	$0	$0	$0
P4-9	Expand GA Building	$0	$266,920	By the end of 2028	10	$0	$0	$0
	Auxiliary Facilities	**$1,585,000**	**$15,829,427**			**$158,500**	**$134,725**	**$1,450,275**
P4-10	Aircraft Maintenance facilities	$0	$13,240,170	By the end of 2028	30	$0	$0	$0
P4-11	Expand Commercial Apron	$1,500,000	$0	By the end of 2028	10	$150,000	$127,500	$1,372,500
P4-12	Expansion of maintenance and storage facilities	$85,000	$0	By the end of 2028	10	$8,500	$7,225	$77,775
P4-13	Expand Storage Capacity tar Jet A	$0	$694,705	By the end of 2028	70	$0	$0	$0
P4-14	Expand Storage Capacity for AvGas	$0	$1,570,052	By the end of 2028	70	$0	$0	$0
P4-15	Catering facilities	$0	$324,500	By the end of 2028	30	$0	$0	$0
	Passenger Terminal Facilities	**$2,455,000**	**$0**			**$849,500**	**$722,075**	**$1,732,925**
P4-16	Terminal Building extension	$1,500,000	$0	By the end of 2028	10	$150,000	$127,500	$1,372,500
P4-17	Ticketing Counters	$55,000	$0	By the end of 2028	50	$27,500	$23,375	$31,625
P4-18	Handling Luggage System	$60,000	$0	By the end of 2028	70	$42,000	$35,700	$24,300
P4-19	FIDS	$25,000	$0	By the end of 2028	75	$18,750	$15,938	$9,063
P4-20	CCTV	$30,000	$0	By the end of 2028	75	$22,500	$19,125	$10,875
P4-21	Security Equipment X-Rays	$785,000	$0	By the end of 2028	75	$588,750	$500,438	$284,563
	Land side and Site Development Facilities	**$0**	**$742,702**			**$0**	**$0**	**$0**
P4-22	Parking Facilities extension and circulation road	$0	$742,702	By the end of 2028	10	$0	$0	$0
	Air Cargo Terminal Facilities	**$0**	**$850,000**			**$0**	**$0**	**$0**
P4-23	Cargo Terminal Expansion	$0	$850,000	By the end of 2028	10	$0	$0	$0
	Subtotal	$5,615,000	$20,918,666		$26,533,666	$1,221,750	$1,038,488	$4,576,513
	TOTAL (Constant Dollars January 2007)	$28,173,696	$52,482,434		$80,656,130	$8,844,683	$7,092,980	$21,080,716

Appendix A

RECAP OF COST ESTIMATES

PLANNING PERIOD (2009-2028)	Investments from Operations	Investments from Others or Delayed	Finalization Date		US Insurers	Ex-Im Bank	ADB Financing
Airside	$7,968,614	$5,537,000	By the end of 2028		$1,442,361	$1,226,007	$6,772,607
Navigational Aide	$634,000	$0	By the end of 2028		$507,500	$431,375	$202,625
General Aviation Infrastructure	$0	$10,012,144	By the end of 2028		$0	$0	$0
Auxiliary Facilities	$7,124,737	$22,037,361	By the end of 2028		$969,724	$824,265	$6,300,472
Passenger Terminal Facilies	$10,513,970	$0	By the end of 2028		$4,389,135	$3,730,850	$6,783,120
Landside and Site development Facilities	$1,902,375	$10,015,929	By the end of 2028		$1,035,863	$880,483	$1,021,892
Air Cargo and Customs Terminal Facilities	$0	$4,880,000	By the end of 2028		$0	$0	$0
GRAND TOTAL	$28,173,696	$52,482,434		$80,656,130	$8,344,683	$7,092,980	$21,080,716

NOTE:

General aviation area is not a part of this project, but may be considered in the long term

Industrial park development is not may part of this project, but further enhance the development of the area

The new ARFF & AMB building is not included in final construction cost

The new control tower is not included in the construction cost

The consideration of the cargo terminal may be a franchised operation and not provided in project financing

Runway provisions will follow the a minimum level of service in this manner;

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SECTION 9: ENVIRONMENTAL IMPACT ANALYSIS

The Terms of Reference call for an Environmental Impact Analysis of the selected airport development program. The issues to be analyzed include impacts on national parks, endangered species, protected lands, noise, water quality, possible impact of drainage on agriculture, air quality and emissions, oil spillage, sewage treatment and impact on flora and fauna, etc.

The TOR also specifies that analysis of aircraft noise impact is to be performed using the FAA Integrated Noise Model (INM) to estimate aircraft noise impacts in terms of noise contours for each scenario (runway direction and planning horizon) and to apply these to the areas surrounding the airport in order to determine the noise exposure levels vs. different types of land use. Recommendations are to be made regarding the implementation of any land use controls not currently in place that may be required by law or zoning ordinances.

The analysis presented in this chapter is intended to provide a preliminary evaluation of the impact of the proposed airport development program upon the environment, pursuant to international best practice. Based on the conclusions of the Inception Report and the evaluation and selection of options as indicated in Section 6 of the present report, conversion of the military airfield at Nacala to a civilian airport capable of accommodating domestic, regional and international commercial flights constitutes the recommended priority development program. The development of the proposed airport facilities is intended to act as a catalyst to attract additional tourism to the Nacala area, in addition to contributing to the development of a Special Economic Enterprise Zone in the Nacala Region. Analysis of the environmental impact of the Nacala development program will consider compliance with the requirements of the applicable laws of the Republic of Mozambique and the requirements established by the World Bank for the sake of approved environmental issues.

Overall objectives of the present Environmental Impact Analysis are as follows:

- to identify the significant environmental effects of the project;
- to describe and quantify (where possible) these effects;
- to describe feasible mitigation measures for minimizing, eliminating or offsetting unavoidable adverse effects;
- to recommend the most appropriate mitigation and/or enhancement measures.

Environmental impacts are potentially associated with three broad aspects of the proposed project: (1) impacts due to project location, (2) impacts resulting from construction activities, and (3) impacts associated with airport operations:

- Impacts resulting from the location of the project include changes and/or disruption of local or regional land values and other socioeconomic activities as well as changes in the physical characteristics of the landscape.

- Impacts resulting from construction activities can create both temporary and long term problems including loss of water quality and quantity, disruption of traffic and transportation patterns, and soil erosion.

- Impacts resulting from airport operations can create on-going environmental impacts related to noise, waste generation and disposal, increased road traffic, conflict with surrounding land uses and resource requirements of airport operation in terms of water and energy consumption, thus requiring mitigation to ensure compatible operation of the proposed facility.

9.1 Environmental Context

9.1.1 Location of the Airport and Description of the Surrounding Area

Nacala Airport is located in the Province of Nampula, approximately 5-6 km North of the city of Nacala on the Western side of a peninsula separating the Indian Ocean from the sheltered deep water port of the Bay of Nacala. Construction of the airfield within the limits of an active military base was completed in 1969.

The airfield is located approximately 125 meters above sea level near the Eastern shore of Nacala Bay. The airside and landside areas contain large expanses of flat, open and well-drained land, allowing for relatively unconstrained development of civil and commercial aviation facilities as well as other related land uses. The surrounding terrain outside the military base is characterized mainly by natural vegetation and small-scale agricultural cultivation; the predominant vegetal cover is mostly shrubs and grasses in an open land landscape with widely scattered trees.

The runway is situated in a North-South orientation, on a ridge running in the same direction parallel to the shoreline of the bay. The land slopes down and away from the airport facilities on both sides of the runway. To the east, the land descends to a creek system running parallel to the runway; the Northern part flows North and empties into the Baia de Fernao Veloso while the Southern part flows South into an estuary on the Eastern side of the peninsula and from there into the Indian Ocean. To the West, the land descends gradually to a public road running parallel to the runway and from there the land slopes further down to the shore of Nacala Bay. The land also slopes away from the runway ends to the North and the South.

Ground access to the airport is provided by a public road on the Western side of the military base running in a North-South direction parallel to the shoreline of Nacala Bay connecting Nacala City to the South with the resort community of Maaia to the North at

the tip of the peninsula. A short East-West road within the military base and along its Southern edge connects this public road with the airport facilities.

The land in the immediate vicinity of the airport is sparsely inhabited except for the area along the above-mentioned North-South public road. Small communities are located to the Northwest and the Southwest of the military base on the Western side of the public road.

Two different geological formations can be identified on the Nacala peninsula. At the project site, however, granite dominates the landform. Sand dune fields of different periods are found throughout the peninsula. The margin slopes of the subject site are gentle and progressive, providing extensive drainage without the presence of permanent artificial waterways. Normal drainage is carried out by numerous natural water courses that have developed in the area.

Based on field investigations and a review of aerial photographs of the area, there are no natural or man-made areas characterized as wetlands in the immediate area of the proposed airport development. A review of the soils in the immediate area of the airport indicates that the soils are described as red lateritic and peristaltic soils of low fertility and are susceptible to erosion.

9.1.2 Climate

The proposed project is located in a region where two climatic regimes overlap: the East African Monsoon System, in which air circulation alternates between the Northeast during the summer months and the Southwest during the winter months, and the Indian Ocean Subtropical Anticyclone System that rules the predominant Easterly winds.

In general, the climate of Nacala City is tropical to sub-tropical and humid marked by a very high relative humidity of about 80%. The mean annual monthly temperature is about 26°C with a peak in December of approximately 32°C and a low in July of 18°C. The region has two distinct seasons; a rainy season and a dry season. The rainy season extends from October to March with mean monthly precipitation ranging from 92 mm in October to 217 mm in March. The dry season extends from April to September with mean monthly precipitation ranging from 0.9 mm in April to 42.74 mm in September. The monthly average values never exceed 50 mm of precipitation during the winter months. The mean annual rainfall is 800 mm.

Fog is generally uncommon. During the May-September period, visibility is occasionally limited to about one kilometer approximately 1% of the time. In the wet season, visibility can also be poor during periods of heavy rainfall.

The configuration of the peninsula and its location offers shelter from winds and the relatively frequent occurrence of cyclones along the northern coast of Mozambique. Winds are generally not strong except during cyclones. Northeast winds dominate from

October to February and Southwest winds from March to September. The region is regularly struck by tropical storms originating in the central Indian Ocean mostly from November to April and may feature gale force winds (greater than 60 km/h) and large amounts of precipitation. The annual frequency of occurrence of these storms in the Mozambique Channel was 3.1 in the period between 1911 and 1960. According to statistics from the *Instituto Nacional de Metereologia*, 23 cyclones have affected the Mozambique coast over a period of thirty years (1969-1999). During tropical storms, rainfall may be far above the mean values. Some cyclones reach the coastal zones of Nacala and lose force as they move to the interior. This whole area, mainly along the coast, is influenced by monsoons.

9.1.3 Description of the Project

At present, there are no civil aviation facilities at Nacala; therefore the proposed conversion of the existing military airfield will require the provision of all landside infrastructure facilities, such as access roads, vehicular parking areas, terminal building, specialized airport equipment and installations, electrical power, water supply and distribution systems, waste water collection and treatment systems, telephone lines, aviation fuel farm, and airfield maintenance areas, etc.

Following is a summary of the recommended airport development program as detailed in Section 7 of the present report.

1 Transfer of land management to ADM
2 Runway resurfacing – Asphalt 10 cm
3 Runway shoulders – 7.5 m both sides of runway – Asphalt 6 cm
4 Runway end safety areas – 90 x 90 m both thresholds – Asphalt 6 cm
5 Taxiway resurfacing – Asphalt 10 cm
6 Taxiway shoulders – 7.5 m both sides of taxiway – Asphalt 6 cm
7 Access taxiway resurfacing – Asphalt 10 cm
8 Access taxiway shoulders – 7.5 m both sides of taxiway – Asphalt 6 cm
9 Commercial apron resurfacing – Asphalt 10 cm
10 Apron shoulders – 7.5 m – Asphalt 6 cm
11 Approach lights – Simplified approach lighting system
12 Visual approach indicator – PAPI
13 Runway threshold/end lights – Red – Green
14 Runway edge lights – White
15 Taxiway edge lights – Blue
16 Indicators and signaling – Lamp direction and signaling
17 Marking – Vertical and horizontal
18 Rescue and fire fighting equipment – Civil Works. Cat 7 Equip. provided
19 Tow tug – Ramp tractor to push out Code D airplanes
20 Ground service equipment – Loader, baggage carts, conveyor belts, pax steps, potable water, toiler service, ground power unit
21 Perimeter fence

22 Perimeter road
23 Access road – 1,600 m from existing public road to meeting building
24 Terminal building – 10 m² per total pax during peak hour. Code D aircraft = 200 pax both ways = 4,000 m²
25 Terminal building – Furniture fixtures and equipment (FFE)
26 Air traffic control tower – Rehabilitation of existing facilities
27 ATC equipment – Air traffic control tower
28 Electrical substation – Transformer 300 kw
29 Emergency generators – 1 of 250 kva + 1 of 100 kva

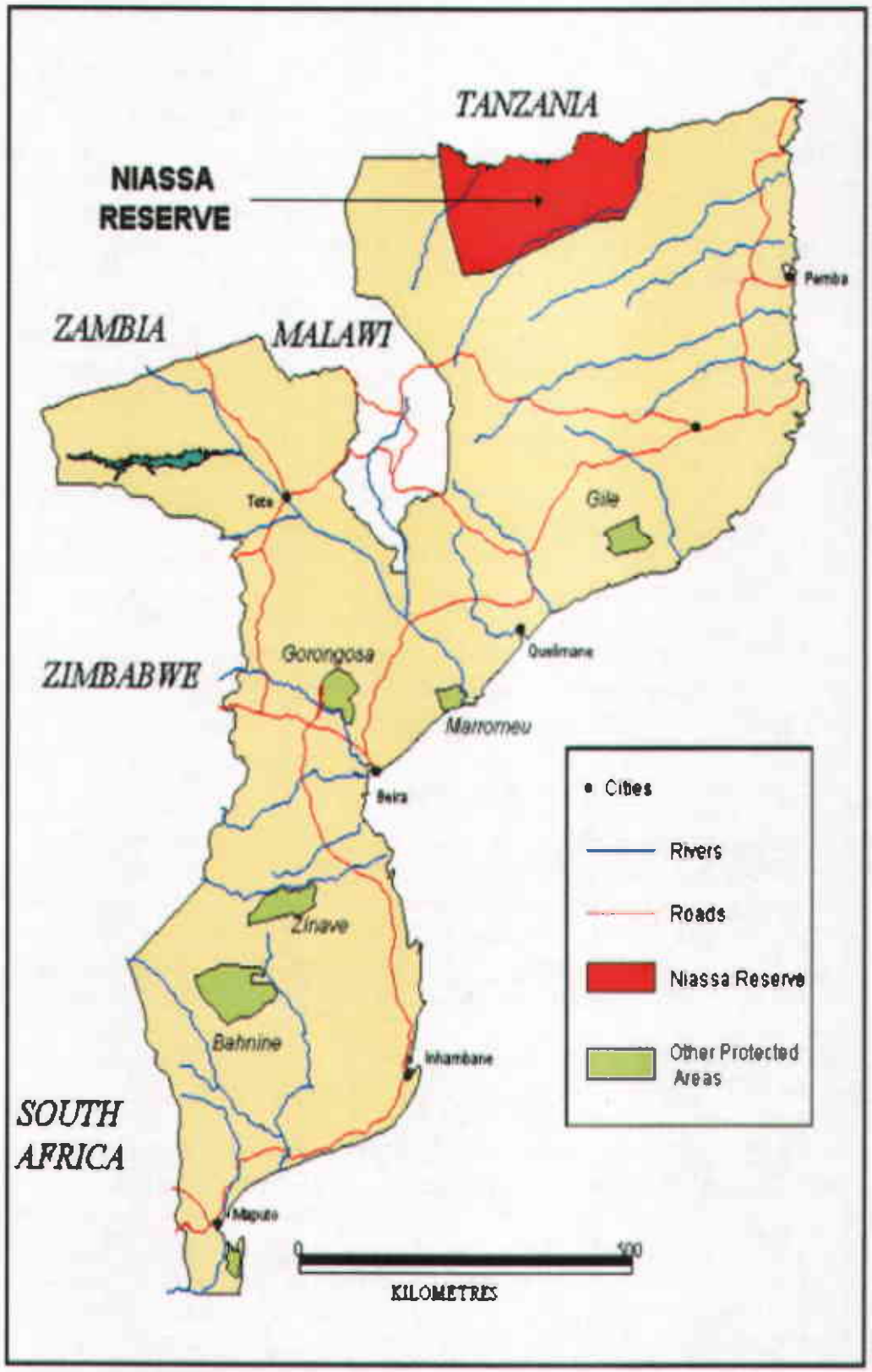
9.2 Potential Impacts

9.2.1 National Parks

Although there are 35 protected zones consisting of National Parks, Forests and Game Reserves throughout Mozambique and covering 11.16% of the total land area (approximately 89,602 square kilometers), none of these are located within the area directly affected by the project (see the following map). We have concluded, therefore, that the proposed development of civilian airport facilities at the Nacala air base site will have no direct impact on any national parks in the immediate area.

With respect to potential indirect environmental impacts on national parks, the development of new airport facilities typically leads to greater patronage by the public, due to the improvement in access. In this case, the existing parks, forests and hunting reserves in Mozambique are already served by other airports which are closer than Nacala; therefore, we have concluded that the proposed airport improvements will not affect patronage at those parks.

Although there are no specifically designated national parks in the tributary area served by the Nacala airport, the improved facilities will permit better access to the other tourist attractions in the general Northern Coastal Region of Mozambique. These include beaches and other maritime assets and, in particular, the World Heritage site of Mozambique Island. Although the latter is not at present designated as a National Park, the improvement of accessibility to this site occasioned by the new airport facilities could provide the impetus for the Government of Mozambique to classify Mozambique Island officially as a National Park in view of its cultural and historic significance. In this sense, the proposed development of the airport facilities is likely to produce a positive impact on National Parks.


TANZANIA
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SOUTH AFRICA
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Niassa Reserve
Other Protected Areas
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KILOMETRES

9.2.2 Flora and Fauna and Endangered Species

Development of expanded airport facilities and increased airport activities may have an impact on the local flora and fauna. Conversely, wildlife and especially birds may also affect airport operations

The Nacala airfield is located within an existing military base and is surrounded by semi-urbanized land. Human occupation has already affected the natural environment of the area surrounding the city of Nacala, including the military base where the airfield facilities are located. There are no listed or proposed endangered or threatened species present in the project area. The development of the new airport facilities, therefore, will not in and of itself represent a significant change in the direct impact on endangered or threatened species of fauna and flora in the vicinity of the airport.

To the extent that the development of the airport will succeed in attracting more tourists and tourism activities to the Nacala region, however, the project may be considered to have an indirect impact on endangered species that could be affected by the increased human presence in potentially sensitive areas.

Although, much of the Mozambique's animal habitat suffered depredation during the civil war and by other human interference over many decades, the coastal areas, were less affected and remain relatively unpolluted, and the islands offshore continue to shelter a rich variety of marine life.

Nacala airport lies approximately 5-6 km from the nearest beaches and areas supporting marine wildlife. In Mozambique's coastal waters, several species of dolphin and turtles can be found and the endangered dugong; a tropical marine mammal. Related to the New World manatee, dugongs can grow to 3 meters in length and weigh up to 170 kilograms. Large and docile, they are hunted for their meat and fat and can become trapped in fishing nets. From a count of around 150 in the early 1990s, there are now thought to be less than 100. Several whale species also inhabit the Mozambique coast during the winter.

Some of the beaches along the Nacala peninsula also serve as major nesting areas for 5 species of marine turtles: green turtle (chelonia mydas), hawksbill (eretmochelys imbricata), olive ridley (lepidochelys oluvacea), loggerhead (caretta) and leatherback (dermochelys coriacea). There are, however, no known turtle nesting areas in the zone affected by project.

Throughout the Nacala peninsula, invertebrates are collected (for local consumption or for sale of sea shells). The main species collected by local communities are sea cucumber (holoturia scabra), sea urchin (echinometra mathai), giant clam (trydacna squamosa), triton trumpet (charonia tritonis), and spiny lobster (panulirus spp), etc.

The environmental management of fishery resources in the country is weak. This is directly related to the destruction of habitats that serve as a source of food, spawning grounds and nursery areas for fish stocks. Some fishing gear also cause heavy damage to sea grass beds and coral reefs. Sea grass beds are a major habitat of fish, dugongs and sea turtles and they occur in almost all the coastal areas around the Nacala Peninsula.

Coral reefs are a major feature along the coastline of the Nacala Peninsula. In certain locations, barrier reefs allow the formation of extensive fine white sandy beaches. Some reefs can be found inside the bay. Living coral reefs play a major role in the formation of coastal landforms and associated ecosystems. These reefs are also extremely important in protecting the sandy embankments from erosion.

Well developed creek mangrove formations occur in Nacala Bay. In creek mangroves, *rhizophora mucronata* and *sonneratia alba* line the canals behind which *bruguiera gymnorrhiza* and *xylocarpus granatum* may dominate. These swamps provide many resources for local communities including insect-resistant wood to build houses and furnishings and the swamps themselves provide erosion control and fish nurseries. More than 50% of the former mangrove area in the region, however, has already been cleared for the construction of salt pans and fishpond development, including almost all the former areas at the head of Nacala Bay.

Mangrove resources play an important role in the social and economic welfare of the people. These include forestry products and mangrove dependent fishery resources that have been extracted from mangrove areas. Mangrove areas also provide other ecological and aesthetic amenities necessary for the further maintenance of the area. They play an important role in the natural functioning of the biological, physical, geological and chemical situation of the environment and deserve to be well managed and preserved for the benefit of future generations.

9.2.3 Protected Lands and Compatible Land Use

The current land use at the site of the proposed Nacala airport includes an active military base. As mentioned previously, the proposed development of civilian airport facilities at Nacala involves the transfer of a portion of the existing military base to civilian control by ADM. At present, the lands used by the military are considered to be "protected lands" in the sense of Articles 7 and 8 of the Land Law of Mozambique.

As discussed in Section 4.1 of the present report, these two articles create "Total Protection" and "Partial Protection" zones, where no right of use and benefit may be granted, but licenses for economic activities may be obtained. Article 8(i) lists airport facilities specifically as Partial Protection Zones and Article 7 names military or defense properties as Total Protection Zones. Development of the proposed civilian airport facilities will therefore require modification of the designation of the land in question from a Total Protection to Partial Protection zone.

According to Article 22(3)(b) of the Land Law, the Council of Ministers can create, modify or extinguish protected zones and, thus has the power to modify the existing Total Protection Zone (for military use) to a Partial Protection Zone (for civilian use). This must be done by an Act of the Council of Ministers. This Article also gives the Council of Ministers the power to increase the land area of the airport if additional land is required for the Partial Protection Zone. If some of the land that is required for expansion is already occupied, Article 18(1)(b) gives the government the right of eminent domain to acquire the land use rights of others for the public benefit.

With respect to protected lands from the point of view of Historical, Architectural, Archaeological and Cultural Resources, the proposed development of airport facilities at the Nacala air base have been reviewed and it appears that there are no cultural materials or historic sites in the project footprint at the Airport.

With respect to protected areas from the point of view of ecologically fragile lands (i.e., steeply-sloped, arid, or forested terrain), the Nacala Airport area does not fall into this category according to the World Bank Environmental criteria. This being said, erosion in other parts of the Nacala peninsula is a serious concern, affecting for the most part urban development in Nacala City. The soils of Nacala City are mainly sandy soils from the quaternary. These are yellow, loose and susceptible to erosion during the rainy season. Sandstone formations protrude in areas where the sandy layer has been washed away by rain. In March 1985, 48 hours of heavy rain caused siltation downtown (through the deposition of sands from surrounding slopes). The siltation caused destruction of paved roads and extensive ravine formation. Because of slope and the hazard of erosion, the soil requires special conservation practices.

Finally, no residences or other sensitive developments located within the area will be impacted by the proposed airport development and aviation operations. The proposed development plans in this environmental analysis are therefore consistent with current and future planning.

9.2.4 Noise

At the conclusion of Section 9 are the following items: Integrated Noise Model, Flight Data Report, Flight Paths 2028 Case Study, Echo Report. These items display the noise contours of the Nacala Airport and the surroundings areas.

ADM provides guidelines to determine if a noise analysis would contribute to this environmental analysis. The integrated noise model has been performed and will be included as a separate appendix to this document.

There are no residences or developments off either end or to the side of the runway, which would be impacted by the introduction of larger passenger aircraft at Nacala airport, whose noise-emitting characteristics do not differ significantly from that at other

airports in Mozambique. The findings of the proposed action will have no significant adverse impact on the environment. Future development is not anticipated to be restricted because of current or future noise impacts.

9.2.5 Water Quality

Pollution from the airport in the form of sanitary liquid and solid wastes and surface runoff containing oils, chemicals and other hazardous materials can significantly degrade water quality and thus impair beneficial water uses, creating a number of serious negative effects on human health. In the case of the proposed development of civilian airport facilities at Nacala, the expected volume of liquid and solid waste generated by the airport activities is such that the potential impact on the environment can be managed by appropriate design and treatment measures. In particular, pollution of the surrounding water supply can be prevented through proper disposal of toxic materials and pollutants as well as by the installation and construction of adequate sewage collection and treatment systems.

9.2.6 Drainage

Drainage of storm water from the airport can have a potential impact on agriculture in the surrounding area and is related to the previous point regarding the management of the impact of the airport activities on water quality. Usually the "first flush" of surface runoff, soon after rain begins, contains most of the pollutants discharged to the ground between rains.

A relatively dense network of short drainage channels with steep gradients dominates the surface drainage pattern in the airport area. There are no surface water bodies on the existing Airport property or in the area traversed by the right-of-way access road. A visual observation and examination of AAROTEC's photographs of the airport area indicate that the proposed improvements will not disturb any natural or man-made wetlands or intermittent streams.

The airport is drained by both surface infiltration and by culverts and drain tiles which empty into intermittent channels leading toward the estuary and seashore mentioned on Section 9.1.1 of the present report. The proposed development will not disturb the existing drains, but will be able to make use of the existing drainage facilities, including the existing culverts and drainage channels can be reconstructed or rehabilitated to maintain and reinforce the present drainage patterns. Therefore, it is concluded that the proposed project will have no significant or adverse impacts on surface or subsurface drainage, including potential impacts on agricultural activities.

9.2.7 Air Quality and Emissions

Aviation activity in the vicinity of an airport can be a source of air pollution and constitute a danger to the environment in general and human health in particular. The degree of

seriousness of this impact is a factor of the volume of activity and the technology of the aircraft and the airport equipment. In the case of the proposed development of civilian airport facilities at Nacala, the relatively low volume of air traffic will not generate significant quantities of air pollution and will not have an appreciable effect on air quality in the surrounding region. In addition, the phasing in of newer technology aircraft and ground service equipment in the future will further attenuate the impact of airport operations on air quality.

During construction of the new facilities, however, it is likely that air quality in the immediate vicinity of the airport will be affected temporarily by dust and other airborne particulate matter resulting from earth-moving and other related activities. This will affect not only the airport itself, but also the military base and the public road linking the airport with Nacala City.

9.2.8 Oil and Fuel Spillage

Airport activities involve the use of a variety of petroleum and other products that are potentially harmful to the surrounding area. These chemicals typically enter the local environment by means of run-off of storm water from the aircraft parking apron and other airfield surfaces as well as from potential ground infiltration from the aircraft refueling system (storage tanks and distribution and pumping equipment). In the case of the proposed development of civilian airport facilities at Nacala, the storm water drainage from the aircraft parking aprons runs generally in an Eastern direction towards the shoreline of Nacala Bay. The fuel storage facilities will also be located on this side of the airport.

In order to avoid any spillage of fuel or oil pollutants from the new aircraft-parking apron from entering the drainage system and ultimately the ocean, an oil separator system (traps) will have to be incorporated into the new apron drainage system. This will permit the fuel and oil to be washed into the traps where they will then be separated from the storm water. Occasionally, the traps will need to be vacuumed to remove the built up residue of fuel and oil and disposed of properly.

9.2.9 Sewage Treatment

Airport activities can generate significant quantities of sanitary sewage due to the presence of passengers, visitors and employees on the site. In addition, some airport activities such as maintenance of aircraft and equipment may produce sewage requiring special treatment due to the presence of toxic chemicals. In the case of the proposed development of civilian airport facilities at Nacala, sewage from the airport will require proper management and treatment of these wastes prior to there release into the environment.

9.2.10 Solid Waste Disposal and Hazardous Materials

A review of the Nacala Airport property for the presence of hazardous and/or toxic materials was conducted for the airport as part of this environmental analysis. There do not appear to be significant environmentally hazardous materials or violations at present. All solid wastes are handled through local landfill to minimize debris at the Nacala Airport.

Under the definitive Environmental Impact Assessment (EIA), the capability of specific local facilities to handle solid wastes produced by the airport will be identified and assessed. If no solid waste facility is available locally, then the EIA will have to recommend a specific method and location for the disposal of solid waste and hazardous materials generated by the airport.

During the construction and operational phase of the airport development project, it is recommended to minimize the generation of solid wastes and the segregation of hazardous materials at source.

9.2.11 Social Impacts

Relocation of Existing Populations and Infrastructure

As part of the environmental analysis of the proposed Nacala airport development project, we have identified the development areas for the expansion of the facilities on the basis of available maps and aerial photos. It is not anticipated that the proposed development will have significant negative social impacts on the community in terms of relocation of existing populations for the purposes of the construction and operation of the airport facilities.

In addition, no land, businesses, residences, or other property will be affected or otherwise displaced for purposes of mitigating noise or other environmental impacts.

Induced Socio-Economic Impacts

The proposed development of civilian airport facilities at Nacala is not expected to result in any significant shift in the patterns of population movement, increases in the demands on public services or negative impacts on business and economic activity in the area immediately surrounding the airport. In the short term, the construction activities associated with the proposed development program will provide employment for local construction contractors and suppliers for local equipment and material. Actual construction will probably occur over at least two calendar years, depending upon the availability of funds, followed by additional investments over the years.

Beyond the immediate benefits to the local economy from construction expenditures, there are long-term lasting benefits to the population of the airport catchment area as well as to the entire country that would be realized due to the availability of civil and commercial aviation at Nacala Airport. It is clear that the lack of direct air service to the

Nacala region act as a significant restraint on the development of the tourism industry in the local area.

The following benefits will occur as a result of the expansion and improvement of Nacala Airport in Mozambique:

- A more favorable investment climate for industrialization and tourism development will occur as effective air service to the Nacala area is introduced.

- Considerable time savings, comfort, convenience and cost reductions to airline passengers will result from the introduction of more airlines, routes and service frequencies, as well as lower airfares.

- Considerable time savings, comfort, convenience and cost reductions to airline passengers will result from the introduction of more airlines, routes and service frequencies, as well as lower airfares.

- Provision of civilian airport facilities at Nacala will render local businesses more competitive by improving links to the outside world.

- Provision of airport facilities capable of handling domestic, regional and international air service constitutes a necessary pre-condition for the development of a competitive tourism product in the Nacala region.

- The development of civilian airport facilities at Nacala will result in new employment opportunities for the local population at the airport, in the tourism industry and in the local economy in general.

9.3 Environmental Regulations Affecting Airport Development Projects

9.3.1 Local Mozambique Policies and Regulations

As discussed in Section 5.2.2 of the present report, the primary law governing the environmental aspects of the proposed development of Nacala airport is the Environmental Protection Law (Law No. 20/97 of 1 October 1997) and the Regulations on the Environmental Impact Assessment Process (Decree No. 45/2004 of 24 August 2004).

According to the Environmental Protection Law all projects to be undertaken in Mozambique fall into three categories for the purpose of determining the level of environmental impact assessment that is required:

- Category A: requiring a full Environmental Impact Report (EIR)
- Category B: requiring a Simplified Environmental Report (SER)

- Category C: requiring no report, but only adherence to "guidelines of good environmental management"

Projects falling under Category C do not normally require an Environmental Impact Report (EIR) or a Simplified Environmental Report (SER) since the negative impacts are deemed to be negligible, insignificant, minimal or even non-existent. According to this category, there are no irreversible impacts and the positive impacts are clearly higher and more significant than the negative ones.

According to Decree 45/2004, a Preliminary Environmental Information Form must be completed and submitted to the Ministry for the Coordination of Environmental Affairs (MICOA) before a project can receive authorization to commence. If a project is classified as Category C, and thus exempt from filing a pre-project report, MICOA must notify the sponsor of the project within 5 working days of the submission of the Preliminary Environmental Information Sheet.

In response to a letter from ADM dated 30 April 2007 relative to the present feasibility study, MICOA notified ADM by means of a letter dated 15 May 2007 that the activities to be performed at the Nacala Airport fall into Category C (see Section 5.2.2 of the present report). As such, according to the above-mentioned Decree the proposed upgrading of Nacala airport is exempt from filing any environmental report. This ruling follows custom and usage as it has developed in Mozambique with respect to projects involving "installation of equipment within already existing rail-port areas", assuming that an airport is deemed to qualifying as a "port".

This being said, the exemption was issued by MICOA without submission of the required Preliminary Environmental Information Form. In order to ensure compliance with the letter of the law, therefore, the required form should be completed by ADM and submitted to MICOA in accordance with the provisions of the existing legislation and regulations.

9.3.2 World Bank Policies and Regulations

The environmental protection policy of the World Bank focuses on ensuring that projects financed under the Bank's programs will minimize the negative environmental and social impacts of these projects and lead to sound and sustainable development. The strategy of the Bank advocates cost-effective reduction of air and water pollutants that are most harmful to human health. The World Bank supports the protection, maintenance, and rehabilitation of natural habitats and their functions in its region of work. The leading focus of environmental threats deals with outdoor air pollution, water pollution and fragile lands (i.e., lands that are steeply sloped, arid, or covered by natural forests). The environmental issues for outdoor air pollution and water pollution are to prevent deaths and ill health from outdoor fine particulate air pollution, waterborne pathogens and poor sanitation conditions.

To this end, the Bank requires an environmental assessment (EA) of any project proposed for Bank financing and has established a comprehensive set of policies and procedures to guide its operations in this area. These are set out in the Bank's Operational Manual, in which the core guidance is given in the Operational Procedures (OPs). These are concise and focused statements based on the Articles of Agreement of the Bank, its general conditions and policies specifically approved by the Board of Directors. The following paragraphs are adapted from the documentation available on the World Bank web site.

Within the overall set of OPs, ten policies have been established as being critical to ensuring that potentially adverse environmental and social consequences are identified, minimized and mitigated. These are referred to as "Safeguard Policies" and include Environmental Assessment among others. The procedures for Environmental Assessment are described in the Operational Policy (OP 4.01) and the Bank Procedure (BP 4.01) dated 1999. These constitute the umbrella policy for safeguards which include, *inter alia* Natural Habitats (OD 4.04), Pest Management (OP 4.09), International Waterways (OP 7.05), Indigenous People (OD 4.02), Involuntary Resettlement (OP 4.12 and OD 4.30) and Physical Cultural Resources (OP/BP 4.11).

The Bank undertakes screening of each proposed project to determine the appropriate extent and type of Environmental Assessment to be undertaken and whether or not the project may trigger other safeguard policies. Four categories of EA have been established, depending on the type, location, scale and sensitivity of the project and the nature and magnitude of its potential environmental impacts. The EA evaluates a project's potential environmental risks and impacts in its area of influence. The area of influence for any project is determined with the advice of environmental specialists and set out in the EA terms of reference. Global environmental issues include climate change, ozone-depleting substances, pollution of international waters, and adverse impacts on bio-diversity.

The EA is closely integrated with the project's economic, financial, institutional, social, and technical analyses to ensure that (a) environmental considerations are given adequate weight in project selection, siting, and design decisions; and (b) EA does not delay project processing. However, the borrower ensures that when individuals or entities are engaged to carry out EA activities, any conflict of interest is avoided. For example, when an independent EA is required, it is not carried out by the consultants hired to prepare the engineering design.

The EA examines project alternatives, identifies ways of improving project selection, siting, planning, design, and implementation by preventing, minimizing, mitigating, or compensating for adverse environmental impacts and enhancing positive impacts and includes the means of mitigating and managing adverse environmental impacts throughout project implementation. The Bank favors preventive measures over mitigation or compensatory measures, whenever feasible.

The Bank's EA process takes into account the natural environment (air, water, and land); human health and safety; social aspects (involuntary resettlement, indigenous peoples, and physical cultural resources; and trans-boundary and global environmental aspects. This process considers natural and social aspects in an integrated way. It also takes into account the variations in project and country conditions; the findings of country environmental studies; national environmental action plans; the country's overall policy framework, national legislation, and institutional capabilities related to the environment and social aspects; and obligations of the country pertaining to project activities under relevant international environmental treaties and agreements. The policy of the Bank is to initiate the EA process as early as possible in project development and to integrate it closely with the economic, financial, institutional, social, and technical analyses of a proposed project.

The borrower is responsible for carrying out the EA. For Category A projects, the borrower retains independent EA experts not affiliated with the project to carry out the EA. For Category A projects that are highly risky or contentious or that involve serious and multidimensional environmental concerns, the borrower should normally also engage an advisory panel of independent, internationally recognized environmental specialists to advise on all aspects of the project relevant to the EA. The role of the advisory panel depends on the degree to which project preparation has progressed, and on the extent and quality of any EA work completed, at the time the Bank begins to consider the project.

The Bank advises the borrower on the Bank's EA requirements. The Bank reviews the findings and recommendations of the EA to determine whether they provide an adequate basis for processing the project for Bank financing. When the borrower has completed or partially completed EA work prior to the Bank's involvement in a project, the Bank reviews the EA to ensure its consistency with this policy. The Bank may, if appropriate, require additional EA work, including public consultation and disclosure.

World Bank Environmental Assessment Instruments

Depending on the project, a range of instruments can be used to satisfy the Bank's EA requirement: full Environmental Impact Assessment (EIA), regional or sectoral EA, environmental audit, hazard or risk assessment, and environmental management plan (EMP). The Bank's EA process applies one or more of these instruments, or elements of them, as appropriate. When the project is likely to have sectoral or regional impacts, sectoral or regional EA is required.

Environmental Screening

The Bank undertakes environmental screening of each proposed project to determine the appropriate extent and type of EA. The Bank classifies the proposed project into one of four categories, depending on the type, location, sensitivity, and scale of the project and the nature and magnitude of its potential environmental impacts.

Category A: A proposed project is classified as Category A if it is likely to have significant adverse environmental impacts that are sensitive, diverse, or unprecedented. These impacts may affect an area broader than the sites or facilities subject to physical works. EA for a Category A project examines the project's potential negative and positive environmental impacts, compares them with those of feasible alternatives (including the "without project" situation), and recommends any measures needed to prevent, minimize, mitigate, or compensate for adverse impacts and improve environmental performance. For a Category A project, the borrower is responsible for preparing a report, normally an EIA (or a suitably comprehensive regional or sectoral EA) that includes, as necessary, elements of the other Bank environmental review instruments.

Category B: A proposed project is classified as Category B if its potential adverse environmental impacts on human populations or environmentally important areas—including wetlands, forests, grasslands, and other natural habitats—are less adverse than those of Category A projects. These impacts are site-specific; few if any of them are irreversible; and in most cases mitigatory measures can be designed more readily than for Category A projects. The scope of EA for a Category B project may vary from project to project, but it is narrower than that of Category A EA. Like a Category A EA, it examines the project's potential negative and positive environmental impacts and recommends any measures needed to prevent, minimize, mitigate, or compensate for adverse impacts and improve environmental performance. The findings and results of Category B EA are described in the Bank's typical project documentation (Project Appraisal Document and Project Information Document).

Category C: A proposed project is classified as Category C if it is likely to have minimal or no adverse environmental impacts. Beyond screening, no further EA action is required for a Category C project.

Category FI: A proposed project is classified as Category FI if it involves investment of Bank funds through a financial intermediary, in subprojects that may result in adverse environmental impacts. In these cases, the same previous categories (A, B and C) are used where applicable.

Public Consultation

For all Category A and B projects proposed for IBRD or IDA financing, during the EA process, the borrower consults project-affected groups and local non-governmental organizations (NGOs) about the project's environmental aspects and takes their views into account. The borrower initiates such consultations as early as possible. For Category A projects, the borrower consults these groups at least twice: (a) shortly after environmental screening and before the terms of reference for the EA are finalized; and (b) once a draft EA report is prepared. In addition, the borrower consults with such

groups throughout project implementation as necessary to address EA-related issues that affect them.

Disclosure

For meaningful consultations between the borrower and project-affected groups and local NGOs on all Category A and B projects proposed for IBRD or IDA financing, the borrower provides relevant material in a timely manner prior to consultation and in a form and language that are understandable and accessible to the groups being consulted.

For a Category A project, the borrower provides for the initial consultation a summary of the proposed project's objectives, description, and potential impacts; for consultation after the draft EA report is prepared, the borrower provides a summary of the EA's conclusions. In addition, for a Category A project, the borrower makes the draft EA report available at a public place accessible to project-affected groups and local NGOs. For FI operations, the borrower/FI ensures that EA reports for Category A sub-projects are made available in a public place accessible to affected groups and local NGOs.

Any separate Category B report for a project proposed for IDA financing is made available to project-affected groups and local NGOs. Public availability in the borrowing country and official receipt by the Bank of Category A reports for projects proposed for IBRD or IDA financing, and of any Category B EA report for projects proposed for IDA funding, are prerequisites to Bank appraisal of these projects.

Once the borrower officially transmits the Category A EA report to the Bank, the Bank distributes the summary (in English) to the executive directors (EDs) and makes the report available through its InfoShop. Once the borrower officially transmits any separate Category B EA report to the Bank, the Bank makes it available through its InfoShop.

Implementation

During project implementation, the borrower reports on: (a) compliance with measures agreed with the Bank on the basis of the findings and results of the EA, including implementation of any EMP, as set out in the project documents; (b) the status of mitigatory measures; and (c) the findings of monitoring programs. The Bank bases supervision of the project's environmental aspects on the findings and recommendations of the EA, including measures set out in the legal agreements, any EMP, and other project documents.

The panel advises the borrower specifically on the following aspects: (a) the terms of reference for the EA, (b) key issues and methods for preparing the EA, (c) recommendations and findings of the EA, (d) implementation of the EA's recommendations, and (e) development of environmental management capacity. These

terms are defined in Annex A. Annexes B and C discuss the content of EA reports and Environmental Management Plans (EMPs).

Guidance on the use of sectoral and regional EA is available in Bank'S EA Sourcebook Updates 4 and 15. A potential impact is considered "sensitive" if it may be irreversible (e.g. lead to loss of a major natural habitat) or raise issues covered by OP 4.10, Indigenous Peoples; OP 4.04, Natural Habitats; OP 4.11, Physical Cultural Resources; or OP 4.12, Involuntary Resettlement. When the screening process determines, or national legislation requires, that any of the environmental issues identified warrant special attention, the findings and results of a Category B EA may be set out in a separate report. Depending on the type of project and the nature and magnitude of the impacts, this report may include, for example, a limited environmental impact assessment, an environmental mitigation or management plan, an environmental audit, or a hazard assessment.

For Category B projects that are not in environmentally sensitive areas and that present well-defined and well-understood issues of narrow scope, the Bank may accept alternative approaches for meeting EA requirements: for example, environmentally sound design criteria, siting criteria, or pollution standards for small-scale industrial plants or rural works; environmentally sound siting criteria, construction standards, or inspection procedures for housing projects; or environmentally sound operating procedures for road rehabilitation projects.

Conclusions

Based on our analysis of the proposed Nacala airport development program and nature of the surrounding lands, the project is not likely to cause any large-scale or irreversible damage to to the physical or social environment, not does the surrounding area fall under the World Bank's definition of fragile or environmentally sensitive lands. Therefore, we believe that the proposed project would not require a full Category A Environmental Assessment according to World Bank policies and regulations. We believe that a Category B Environmental Assessment would be applicable to this project if it were to comply with World Bank policies and regulations.

9.4 Potential Negative Impacts and Mitigation

9.4.1 Summary of Potential Negative Impacts

Construction Phase

The impacts which are likely to occur during the construction phase are the following:

<u>Soil Quality, Erosion and Disposal of Excess Materials</u>

Construction stage impacts include soil erosion and silt runoff during earth moving operations and continuing erosion due to lack of adequate and timely resurfacing and replanting of exposed areas. The construction works could result in modification of the nature and profile of the soils. The construction machinery could also be responsible for accidental spills of contaminants, thus causing a degradation of the soils, the extent of which would be a function of the type of contaminant and the nature of the event.

The construction works will generate a significant volume of removed material, which will have to be disposed of elsewhere on the site as fill material or in an adequate site outside the airport property. During the construction work, inadequate disposal of excess cut material as well as the waste and debris which will be produced (construction debris, demolition, organic waste, etc.) could lead to deterioration of the soil.

Surface and Underground Water Quality

The excavation and earth moving activities will lead to denuding of the soils, which could increase the degree of erosion and thus increase the quantity of sediments and turbidity, especially if the works take place during the rainy season.

Accidental spills of contaminants could also occur during the use of heavy machinery and lead to the temporary degradation of the quality of surface and underground water.

Air Quality

Emission of dust and exhaust gases from vehicles can occur during the construction work, thus modifying locally and for short periods the quality of the air for the inhabitants living around the airport.

Noise and Vibration

The ambient noise level risks are subject to modification during the construction works. Moreover, an increase is to be expected in vibration during the excavation and earth moving work, the construction and the circulation of heavy equipment.

Plant Cover

The construction works are likely to lead to a loss of plant cover as a result of the implementation of site access roads and circulation of vehicles and machinery during the construction works.

Fauna

The loss of plant cover at the site reserved for the construction of landside and airside infrastructures could cause a loss of habitat for the terrestrial fauna.

Utilization of the Road Network

The increase in the volume of traffic (trucks, heavy machinery, etc.) during the period of construction could cause nuisance to the users of the local road network.

Operations Phase

During the Operational Phase of the airport, the principal sources of environmental impact are the following:

Sanitary Sewage, Solid Waste and Hazardous Materials

The airport operations at Nacala will generate sanitary sewage, solid waste and hazardous materials due to the presence of passengers, visitors, employees and other airport users, as well as from technical operations such as aircraft maintenance and servicing. The substances to be managed include domestic waste, aircraft fuel, lubricants, chemical cleaning and treatment agents and possible contaminated waste from aircraft toilets. All of these present potential dangers to the environment if not treated and disposed of properly.

In the case of the proposed new Nacala airport facilities, these substances will be generated primarily at the aircraft parking apron, the passenger terminal building and the other landside installations. Since these are all situated on the Western side of the airfield, their impacts will be felt primarily on the drainage systems flowing in that direction, toward the Bay of Nacala.

Noise due to Aircraft Operations

The airport operations at Nacala will generate noise due to landings and take-offs of aircraft, essentially in a North-South pattern along the runway center-line. As described in Section 9.2.4 of the present report, the forecast volume of aeronautical activity at Nacala is unlikely to create noise at a level that would constitute an appreciable effect on the surrounding areas. Due to the existing and likely future pattern of urban development on the Nacala peninsula, the zones most likely to be affected by noise lie to the South of the airport and to the North of Nacala City along the runway center-line, although the impact is expected to be minimal.

Utilization of the Road Network

The development of commercial airport facilities at Nacala will generate increased vehicular traffic, essentially on the public road linking Nacala City with Maaia. This traffic will consist of passengers and accompanying well-wishers, employees working at the airport and service vehicles related to airport operations (cargo trucks, fuel deliveries, removal of waste, etc.). The pattern of passenger-related traffic will be determined by the amplitude and timing of the forecast passenger peak hour volumes and the flight

schedules. The extent of the other traffic will be determined by the specific activities which will take place at Nacala airport (aircraft maintenance and servicing, cargo, related industrial operations, etc.).

Consumption of Energy and Water

The airport operations at Nacala will generate a requirement for the consumption of electricity and water. The volume of consumption will be related to (a) the population using the airport facilities, i.e. passengers, well-wishers and meeters/greeters, employees and visitors), and (b) the requirements of maintenance and other technical operations.

Wildlife Management

Airport operations represent a potential disruption to the wildlife populations in the immediate area, due to the measures required to control birds and other animals from endangering aircraft movements during flight and on the ground. These measures can include the control of open bodies of water, the restriction of certain plant growth and crops, as well as the introduction of raptors to discourage the presence of birds in proximity to flight paths.

9.4.2 Proposed Environmental Control and Mitigation Measures

Construction Phase

There will be no significant long-term construction impacts associated with the various phases of the proposed airport expansion project if common practice efforts are put in place to avoid soil erosion from surface water, wind, and mechanical displacement of soil. In order to minimize any short-term water quality impacts, all construction at Nacala Airport should be accomplished in accordance with FAA Advisory Circular 150/5370-10, CHG 10, Temporary Air and Water Pollution, Soil Erosion, and Siltation Control. In addition, re-vegetation of all disturbed sites will be fostered during construction in order to minimize any impacts. In addition, construction plans and contract documents should include provisions for monitoring during the construction period to ensure contractor's compliance with specified constraints.

The following specific environmental control and mitigation measures at Nacala Airport are proposed during the Construction Phase:

Soil Quality

- Executing the works during the dry period in order to limit the runoff and erosion of the soil;

- Covering the surfaces which have been exposed and which are sensitive to erosion with the aid of straw mats or nets in order to control and limit erosion;

- At the termination of the construction work, resurfacing, seeding and mulching of the cut area and replanting of exposed areas with a herbaceous stratum or stabilizing shrubs on the unstable soils in order to prevent continuing depletion of soil resources, the release of silt into waterways and degradation of air quality from fugitive dust;

- Limiting the number of traffic lanes and limit the movement of machinery to the work areas and well-demarcated access ways;

- Constructing ditches at least 15 meters from the watercourses in order to confine and direct the water runoff. Construct holding areas in the ditches in order to reduce the velocity of the water flow and thereby limit the erosion;

- Re-establishment of the initial state of the natural and artificial conditions of drainage;

- Taking all possible precautions when refueling transport vehicles and machinery in order to avoid any eventual spills;

- Maintaining all vehicles in good working condition in order to avoid any leakage of oils, fuel and other pollutants;

- Establishing an adequate emergency plan and communicating it to the employees on the construction site in case any accidental spills occur. Equip the areas for the storage of contaminants with the necessary means to enable protection against any accidental spills. Keep a sufficient supply of absorbent materials at the work sites as well as sealed reservoirs identified for receiving petroleum product residues and waste in case of spills;

- Performing a soil analysis at the present locations of the fuel tank farm and the aircraft maintenance hangar in order to verify if there is any contamination. In the event that this is the case, decontaminate the sites prior to paving the surface for the planned expansion of the passenger and cargo aircraft parking aprons; and

- Avoiding the accumulation of all types of waste within and outside the work sites. Evacuate this material to adequate disposal areas.

<u>Surface and Underground Water Quality</u>

- Undertaking the construction works during the dry period in order to limit the runoff and the transport of sediments in the watercourse;

- Limiting the circulation of heavy machinery to at least 60 meters from watercourses;
- Circulating obliquely to the slope in the proximity of watercourses in order to limit the transport of sediments;
- Conserving vegetation on the banks of watercourses;
- Installing temporary sediment traps at the ends of the drainage ditches around the runways in order to avoid the silting up of the water courses adjacent to the work sites and gather the spent filters. Avoiding, however, obstructing the flow of the watercourses, the ditches or other channels. Withdraw the debris which blocks the normal water flows;
- Installing culverts to bridge the drainage ditches. Restoring any broken drains;
- Not handling oil or gasoline less than 60 meters from a watercourse and recuperate all spent oils to be disposed of properly; and
- Maintaining the construction vehicles and machinery in good working condition in order to avoid leakage of oils, fuel and all other contaminants.

Air Quality

- Using particulate air filters on construction equipment; and
- Maintaining the construction vehicles and machinery in good working condition in order to minimize the emission of pollutants.

Noise and Vibration

- Advising residents of the duration and the progress of the works;
- Reducing the noise to a minimum in order minimize the nuisance as much as possible for the residents of the sector. Organizing the work schedules and the construction activities taking into account the nuisances caused by the noise. Avoiding the circulation of heavy vehicles and the undertaking of heavy work outside normal work hours; and
- Maintaining the construction vehicles and machinery in good working condition in order to minimize the generation of noise.

Plant Cover

- Limiting the cutting of the vegetation strictly to the zones necessary for the construction of the new infrastructures and the implementation of site access and circulation roads, and limit the circulation of vehicles and machinery. Conserving the root system of shrubs; and

- Encouraging the planting of shrubs at the completion of the construction works in the zones which are sensitive to erosion.

Fauna

- Limiting the interventions to the sectors specifically identified in the plans and specifications. Avoiding the circulation of vehicles beyond the marked access and circulation roads, as well as the storage of excess cut materials at sites outside those specifically required.

Utilization of the Road Network

- Establishing clear circulation plans jointly with the municipal authorities and utilize adequate signage during the period of the construction works;

- Adjust the schedule of the construction works in order not to disturb traffic circulation at peak hours;

- Regularly clean the roads used by the construction vehicles in order to remove the accumulation of loose material and other debris;

- Advise the users concerning the progress of the construction works;

- Undertake tests prior to the beginning of the construction works in order to ensure that the telecommunications systems on the site do not interfere with the activities of the control tower which involve the use of this system; and

- Develop and publicize a plan to re-route passengers and other airport users so as to avoid the zones under construction.

Operations Phase

The following specific environmental control and mitigation measures at Nacala Airport are proposed during the Construction Phase:

Sanitary Sewage, Solid Waste and Hazardous Materials

- Install separators to remove petroleum and other hazardous substances from the storm drainage system associated with the aircraft parking apron

- Install an appropriate waste water treatment system for the sanitary sewage generated by the airport, taking into account the volume and specific characteristics of the waste being generated and the need for a system with low maintenance and operating requirements

- Install a special procedure and facility to handle potentially contaminated waste from aircraft toilets

- Install a special procedure and facility to handle hazardous materials

Noise due to Aircraft Operations

- Enact and enforce land use regulations to prevent the occupation of land subject to future impact of noise from airport operations by residential development, schools, hospitals and other incompatible facilities and activities

Utilization of the Road Network

- Improve the public road linking Nacala City and Maaia by means of an appropriate surface and reinforcing where necessary

- Install a coherent and complete signage system to direct airport-related traffic on the public road linking Nacala City and Maaia, as well as on the city streets within Nacala City

- Construct a dedicated intersection for civilian airport-related traffic independent of the traffic related to the military base

Consumption of Energy and Water

- Ensure that the airport has an adequate and reliable supply of electricity without depriving the other users of the needed power

- Ensure that the airport has an adequate and reliable supply of potable and process water without depriving the other users of the needed water.

9.4.3 Proposed Treatment Facilities

Treatment facilities are crucial and necessary in order to prevent the hazardous potentials of pollution of water, agriculture, air, etc, and for the protection of the health of the livelihood of people, livestock and flora and fauna in the areas surrounding the project area of Nacala Airport.

The proposed treatment facilities for Nacala Airport are:

- Installation of an oil separator system as part of the storm drainage network;
- Upgrading of the existing storm drainage system;
- Improving the sanitary sewage system.

9.4.4 Costs of Environmental Mitigation/Treatment Measures

The environmental impact analysis included in this report represents the first phase in identifying and evaluating the potential effect of the project on the environment. If ADM decides to proceed with implementation of the proposed airport development program at Nacala, a more detailed Environmental Impact Assessment (EIA) will be required, in line with the requirements of Mozambique law and the guidelines of the World Bank.

The final designs and specifications, as well as the construction works and procedures, will need to comply with the various environmental standards, directive and measures stipulated by ADM and the Republic of Mozambique official Decree number 45/2004. In the event that the World Bank or other international development banks participate in the financing of the proposed program, then the principles set forth by in Section 8.2.2 of this report will also apply.

Basic information required to conduct a full-scale EIA includes maps, aerial photographs to 8 km beyond the proposed airport boundary, on-site confirmation of land use patterns, local climatological and hydrological data. Additional information as listed below:

<u>Characteristics of the physical and chemical environment and the utilization of natural resources</u>

- Meteorological and climatological characteristics
- Geological characteristics
- Hydrological characteristics of ground water
- Soil characteristics and utilization
- Agricultural areas
- Hydrological characteristics surface water
- Present and planned usage of surface water sources
- Surface water ecology
- Protected areas
- Forest areas
- Flora and fauna
- Husbandry
- Minerals and fossil fuel resources
- Aesthetically valuable landscape
- State owned lands

Population and land use in the vicinity of the project

- Transportation
- Utilities/services
- Cultural/historical resources
- Urban and rural land use
- Income and employment
- Unemployment
- Health and endemic disease

Construction phase activities

- Extent and location of excavation
- Material source areas
- Extent and location of fill or construction over water
- Safety assurance activities
- Flood prevention
- Toxic and dangerous substance handling
- Fugitive dust control
- Excavate material disposal
- Transportation infrastructure plan
- Water supply system
- Utility provision
- Fuel requirements.
- Waste water generation, treatment and disposal
- Solid waste generation, treatment and disposal
- Vibration and noise
- Vegetation removal
- Agricultural land lost
- Construction workers camps
- Worker health and safety
- Landscaping/restoration

Airport Operation

- Facilities and functions
- Toxic and hazardous materials storage and handling
- Vehicles and equipment
- Services and market characteristics
- Water consumption patterns
- Fuel consumption requirements
- Solid waste generation and disposal
- Noise and vibration
- Personnel housing/infrastructure
- Health and safety

- Landscaping

Environmental Impact Statement

Under the guidelines of the World Bank, the preparation of a full-scale Environmental Impact Assessment is part of a process which includes the drafting of an Environmental Impact Statement (EIS) and the submission of this document to the appropriate authorities. The EIS includes a complete description and analysis of all issues relevant to the development of the proposed facility and the means by which those issues can be addressed.

The EIS must consider the extent to which the expected effects of the development are consistent with the provisions of any Development Plan, the Planning Strategy. The EIS should also state the proponent's commitments to meet conditions (if any) placed on any approval that may be given to avoid, mitigate or satisfactorily control and manage any potential adverse impacts of the development on the environment.

Aims of the EIS and Public Review Process

To provide a source of information from which interested individuals and groups may gain an understanding of the proposal, the need for the proposal, the alternatives, the environment which would be affected, the impacts that may occur and the measures to be taken to minimize these impacts.

To provide a forum for public consultation and informed comment on the proposal and to provide a framework within which decision-makers may consider the environmental aspects of the proposal in parallel with social, economic, technical and other factors

The EIS Process

- Following the release of the Guidelines adopted by the environmental review panel established by the competent authority, the EIS must be prepared by the proponent in accordance with these Guidelines. The EIS is then referred to any prescribed authority or body, and to other relevant authorities or bodies for comment.

- Public exhibition of the EIS document by advertisement is undertaken for a least 30 business days. Written submissions are invited.

- A public meeting is held in the locality by appropriate Planning Authority during the period for making submissions to provide information on the development or project, to explain the EIS document and processes, and to assist interested persons to make submissions.

- Copies of the submissions from the public and other relevant agencies will be given to the (the proponent) soon after closing of the public comment period.

- The proponent must then prepare a written response in a "Response Document" to the matters raised by the Minister or any prescribed or specified authority or body and the public.

- The Minister then prepares an Assessment Report taking into account any submissions and the proponent's response to them. Comments from any other authority or body may be considered as the Minister thinks fit.

- The Assessment Report and the Response Document are to be kept available for inspection and purchase at a place and period determined by the Minister. Availability of each of these documents will be notified by advertisements in the newspaper and local press.

- A copy of the EIS, the Response Document prepared by the proponent and the Assessment Report will be given to the Government for distribution purposes.

The Government of Mozambique is the relevant decision-maker with respect to when a development application is subject to the EIS process. The Government must have regard to the following in arriving at a decision

- Provisions of the appropriate Development Plan and regulations
- If relevant, the Building Rules
- The Planning Strategy
- EIS and Assessment Report

Environmental Impact Document

The Guidelines set out the major issues associated with the proposal and their degree of significance as determined by the Panel. It describes each issue and then outlines the way that these issues should be dealt with in the Environmental Impact Statement. In these Guidelines the terms "description" and other similar terminology should be taken to include both quantitative and qualitative materials as practicable and meaningful. Similarly, adverse and beneficial effects should be presented in a quantitative and/or qualitative terms as appropriate.

The main text of the EIS should be clear and precise and presented in terms that are readily understood by the general reader. Technical details should be included in the appendices so that the EIS forms a self-contained entity.

The document should give priority to the major issues associated with the proposal. Matters of lesser concern should be dealt with only to the extent required to demonstrate

that they have been considered to assist in focusing on the major issues. The following should be included in the EIS:

Summary

The EIS should include a concise summary of the matters and include all aspects covered under the headings set out in the Guidelines below, in order for the reader to obtain a quick but thorough understanding of the proposal and the resulting environmental impact.

Introduction

The introduction to the EIS should briefly cover the following:

- Background to, and objectives of, the proposed development
- Details of the proponent
- Staging and timing of the proposal, including expected dates for construction and operation
- Relevant legislative requirements and approval processes
- Purpose and description of the EIS process

Need for the Proposal

This should briefly cover the following:

- The specific objectives that the proposal is intended to meet, including market requirements
- Expected local, regional and state benefits and costs, including those that cannot be adequately described in monetary or physical terms (e.g. effects on aesthetic amenity)
- A summary of environmental, economic and social arguments to support the proposal, including the consequences of not proceeding with the proposal
-

Description of the Proposal

The description of the proposal should cover a description of the existing environment, the nature of the proposal and the location, construction and commissioning timeframes, and a description of construction, operation, maintenance and monitoring practices and techniques. This should include reference to the location, layout, elevation and appearance of structures (and buildings where relevant), an indicative land division plan, a description of easements and infrastructure requirements and availability. A

discussion of management arrangements for the construction and operational stages should be provided.

Assessment of Expected Environmental, Social and Economic Effects

The assessment of effects should include all issues identified in these Guidelines.

Consistency with Government Policy

The EIS is to state its consistency with the relevant Development Plan and Planning Strategy.

Avoidance, Mitigation, Management And Control Of Adverse Effects

The proponent's commitments to meet conditions to avoid, mitigate, satisfactorily manage and/or control any potentially adverse impacts of the development on the physical, social or economic environment must be clearly stated as part of the EIS. The design of the proposal should be flexible enough to incorporate changes to minimize any impacts highlighted by this evaluation or by post-operation monitoring programs.

Sources of Information

The sources of information (e.g. reference documents, literature services, research projects, authorities consulted) should be fully referenced, and reference should be made to any uncertainties in knowledge. Where judgments are made, or opinions given, these will need to be clearly identified as such, and the basis on which these judgments or opinions are made will need to be justified. The expertise of those making the judgments including the qualifications of The AAROTEC Teams and authorities should also be provided.

Appendices

Technical and additional information relevant to the EIS that is not included in the text should be included in the appendices (maps, graphs, tables, photographs, reports etc). A glossary may also be appropriate.

Other

Appropriate drawings, including plans and elevations, are needed for a decision to be made. As much information as possible is required of the design and layout of the proposal.

The specific issues to be included for consideration in the EIS, according to World Bank guidelines, include the following:

Main Issues

The Main Issues will be identified and discussed. The discussion will include the advantages and disadvantages along with any alternatives that may be available.

Proposal

Describe the need for the proposed development, including the reasons for its proposed location and staging

Assess the "do nothing" option.

Environmental Issues

Coastal

Outline the visual effects on the coast of the development in this locality generally.

Describe the effect of land reclamation and construction of the breakwaters and entrance channel on sea grass and sand movement on the coast.

Outline management and rehabilitation measures for impacts on the coast.

Describe the effect of the development on terrestrial and marine native flora and fauna.

Identify measures to minimize vegetation clearance, including incorporating remnant stands in the layout design, and to compensate for the loss of native vegetation and habitat.

Detail the measures to protect dunes, tidal flats and beach during and after construction, including buffers.

Water

Describe the general impact of increased recreational and commercial boating on water quality.

Outline measures to protect and maintain suitable water quality in waterways, particularly the management of run-off and the control of pollutant and microorganism sources.

Detail how sufficient water turn-over rates and flushing will be achieved for the marina basin and waterways.

Describe the impact that water discharged from the development would have on the health of fish and other marine species.

Outline measures to protect and monitor water quality in the marine environment from commercial fishing/aquaculture activities, including maintenance and repair.

Describe the approach to water sustainability, including ways in which mains water supply use can be minimized or supplemented and opportunities for reducing and recycling water, particularly storm water.

Describe water sensitive urban design measures and uses of wastewater that could be adopted.
Outline measures to protect and maintain suitable water quality in the constructed wetlands.

Groundwater and Land Contamination

Describe the known existing groundwater and land related environmental conditions, including possible contamination sources.

Describe the short and long term effects of constructing channels and basins on land and/or groundwater quality and movement.

Describe storm water and wastewater management and the potential impact on land and/or groundwater.

Detail the measures to be taken to manage and monitor groundwater resources.

Environmental Management

Describe the sewage disposal and rubbish collection systems for commercial and recreational boats and the potential for incorporating recycling and resource recovery.

Outline waste management strategies for households and tourist facilities and the potential for incorporating recycling and resource recovery.

Detail arrangements for managing solid waste, black water and grey water.

Describe the use of amenity/landscape plantings and broad scale revegetation, including the opportunities for the use of locally endemic species.

Describe how the spread of pest plants and animals within and around the development would be managed.

Describe the risk of causing or exacerbating any environmental problems in the locality, and describe mitigation measures and their expected effectiveness. Outline the effects of boating traffic and additional people on the surrounding environment and how impacts would be managed, particularly for environmentally sensitive offshore islands.

General

Detail the scope of investigations required to include in an environmental management plan.

Describe how all potential sources of air pollution (especially dust) would be controlled and monitored, including measures for the reduction or elimination of dust.

Describe the benefits of the proposal to the local environment.

Detail measures for rehabilitating the coastal estuary into a water body that would function for both recreational/commercial uses and as a natural ecosystem, particularly the establishment of a suitable hydrological regime

Detail measures to ensure that residential, recreational and commercial activities would be conducted in an environmentally sustainable manner, particularly to protect water quality.

Identify opportunities for energy conservation.

Effects on Communities

Provide information on the expected levels of environmental noise associated with the operation of the facility, identifying all potential noise sources, and describes the extent to which these noise emissions could be reduced and contained to minimize the effects upon the wider locality.

Outline the size and source of the construction workforce and identify how accommodation requirements would be met.

Detail opportunities for Aboriginal employment.

Describe the effect on visual amenity and landscape quality, especially the effects of the built form of structures (including the breakwater, earthworks and power lines) and impact on the coastal environment, particularly as viewed from the community.

Identify impacts on local amenity, including the potential build up of sea grass on adjoining beaches.

Outline the expected character of the residential development, including the likely demographics of the marina community, provision of affordable housing, accessibility (especially for people with disabilities), opportunities for passive recreation and crime prevention initiatives.

Describe how the proposal would be integrated with the community.

Identify the effects on the existing character and lifestyle of the community, including existing cultural and heritage values of the area.

Outline the traffic generation and truck movements to and from the site and their hours of operation during the construction period, particularly the impact on the public road linking Nacala City with Maaia. Outline the impact of rerouting the any highways and roads, particularly the effect on adjoining landowners and existing businesses. Describe the implications for the full range of public and private service providers including health, aged care, education, transport and recreation to support the development in the short, medium and longer term.

Detail the consequences of establishing a safe haven for the recreational and commercial boating fraternities if affecting boating areas.

Social Issues

Outline the impact on existing tourism and recreation activities and infrastructure, including integration with any existing recreational facilities.

Describe the impact on local and regional land uses, such as shellfish aquaculture.

Describe the potential impact of adjoining land uses on the development.

Describe the impact on the nearby homeland settlement, particularly access to the community and school bus routes.

Describe the land tenure arrangements for the marina and the opportunities for commercial, private recreational or public access to berths, launching facilities or other associated facilities.

Outline the location and availability of public facilities including telephones, toilets, showers and the lighting of public areas.

Describe the benefit and amenity improvements due to infrastructure changes.

Describe how access to the public foreshore would be maintained, enhanced and managed.

Detail attenuation measures to minimize the noise emission impacts of potentially incompatible uses within the development area.

Identify the impact of the rerouted highways and roads on the amenity of residents and visitors of the development, particularly noise.

Identify opportunities for recreational activities, particularly walking, cycling and water sports.

Describe the nature of the medium density housing in regard to urban form and amenity, including provision for car parking.

Economic Issues

Outline the opportunity for tourism and investment in the area arising from the proposal.

Identify employment and investment opportunities, including the "multiplier effect".

Identify the economic effect the construction and on-going workforce would have locally and regionally.

Outline the potential for the proposal to attract and enhance the business operations of other allied industries and commercial ventures.

Outline the potential for the proposal to impact upon the business centre of the community and other local businesses through competition and possible duplication of services.

Describe any potential costs or savings to the Government of infrastructure expansion with regard to transport networks, electricity supply, water supply, sewerage, dredging or coastal management.

Describe the sustainability of long-term management of the development, including potential costs and benefits to council and rate payers of long-term management and maintenance of the marina facilities, waterways, entrance channel, breakwaters, residential development and constructed wetlands.

Describe the impact on existing activities and infrastructure at the Ports.

Describe the opportunities for the aquaculture and fishing industries and their support services.

Identify the impact of increased fishing pressure and aquaculture on recreational and commercial fish stocks, including implications for fisheries compliance.

Outline the financial strategies to be employed to ensure the relevant infrastructure is in place for each stage in the project.

Describe the land tenure arrangements during and after construction of each stage.

Detail measures and strategies for the management of hazardous, flammable or explosive materials in the commercial areas or on boats, including risk contours.

Native Title and Tribal Heritage

Identify the effect on any archaeological, anthropological or other significance, including any sites listed in any Register of the National Estate and any Register of Tribal Sites and Objects, or identified after consultation with Tribal councils or groups.

Identify any native title issues in respect of the requirements of the

Describe the impact on any Native Title Claimants and the consequent impact on the potential ongoing enjoyment of native title rights, if any, by native title holders.

Risk and Hazard Management

Describe strategies for ensuring public safety during construction.

Detail procedures to be adopted to confirm whether acid sulphate soils are present and management measures that would be required during construction and operation.

Detail procedures to be adopted to confirm whether the land is contaminated and management measures that would be required during construction and operation.

Describe procedures and strategies to prevent, manage and mitigate pollution spills or sewage leaks.

Describe how the introduction of pest or nuisance marine organisms would be dealt with.

Describe procedures and strategies to manage and monitor invasive weed species to protect coastal vegetation.

Detail flood mitigation strategies including prevention of flooding and operation of waterways.

Identify the seismic risk to infrastructure and reclaimed land, especially the potential for liquefaction.

Identify any risk to the operation of the Airport, especially from bird strike.

Construction and Operational Effects

Provide a site construction plan and outline strategies to minimize effects on the local environment, particularly the ecological impact on mangrove, sea grass and reef communities.

Describe the proposed methodology for dredging and earthworks drainage, dredging frequency, disposal of excavated material and impacts on water quality and the environment, including maintenance activities.

Identify the source and origin of any construction materials, including fill for the breakwaters, revetments and land forming.

Describe the transport and storage of any construction materials to minimize effects on the local amenity.

Identify measures for the control of storm water run-off, groundwater discharges, dust, mud, vibration, noise, odor (including from rotting sea grass and organic soils) and other emissions during construction.

Describe the implementation of environmentally acceptable work practices and monitoring programs, particularly through management plans.

Describe the impact on road networks (including freight corridors) during construction and operation of the development.

Describe the design and operational measures to prevent storm water and other run off from the residential, commercial, community centre and other built areas from entering waterways and the marine environment.

Identify measures to protect any sites of non-indigenous heritage and historic shipwrecks within the declared area during construction.

Outline the impact of dredging and channel maintenance on boat access if affected.

Describe the compatibility of land uses, particularly measures to avoid conflict between commercial fishing/aquaculture and residents/tourists.

Outline management controls for housing and commercial construction activities to minimize social and environmental impacts.

Describe the management agreements between the District Council and the proponent during and after construction.

Detail long-term management agreements for operation of the development, including the ownership of land and infrastructure.

Identify the need for any additional by-laws and encumbrances to control and manage operational activities of the marina community.

Detail the proposed monitoring of impacts during and after construction.

Effects on Infrastructure Requirements

Outline the requirements for an adequate supply and the likely location of distribution networks for gas, electricity, water, sewerage, storm water management, communications systems and local roads.

Describe the impact the development will have on the existing Community effluent treatment system, including the need for infrastructure upgrading or alternative systems to which the development will connect.

Describe the connection to water supply for the development proposal and include information on the quantity of potable water required and the impact on local and regional users.

Outline the changes to be made to the any highway and road and associated traffic management requirements, including the need for a heavy vehicle bypass around the development.

Outline the potential for adopting water sensitive urban design measures for managing storm water.

Outline the feasibility of using constructed wetlands and the golf course for managing storm water run-off.

Describe the feasibility of using the golf course for the disposal of treated effluent, such as wastewater.

Describe the facilities to be provided for waste disposal from recreational and commercial vessels, especially black water, grey water and solid waste (including seafood waste and offal).

Detail emergency services arrangements.

Outline opportunities to incorporate best practice measures of infrastructure design.

Planning and Environmental Legislation and Policies

Describe the proposal's consistency with the relevant Development Plans and the Planning Strategy for Regional South Australia.

Describe the required changes that would need to be made to the zoning of the site.

Describe the consistency of the development with State and Commonwealth legislation and initiatives relating to conservation or protection of the biological environment and heritage items.

Detail any commercial fishing or aquaculture policies and any recreational boating and facilities policies relevant to the proposal.

Detail any other relevant plans or studies that relate to the area and identify legislative requirements and the range of approvals needed to complete the proposed development.

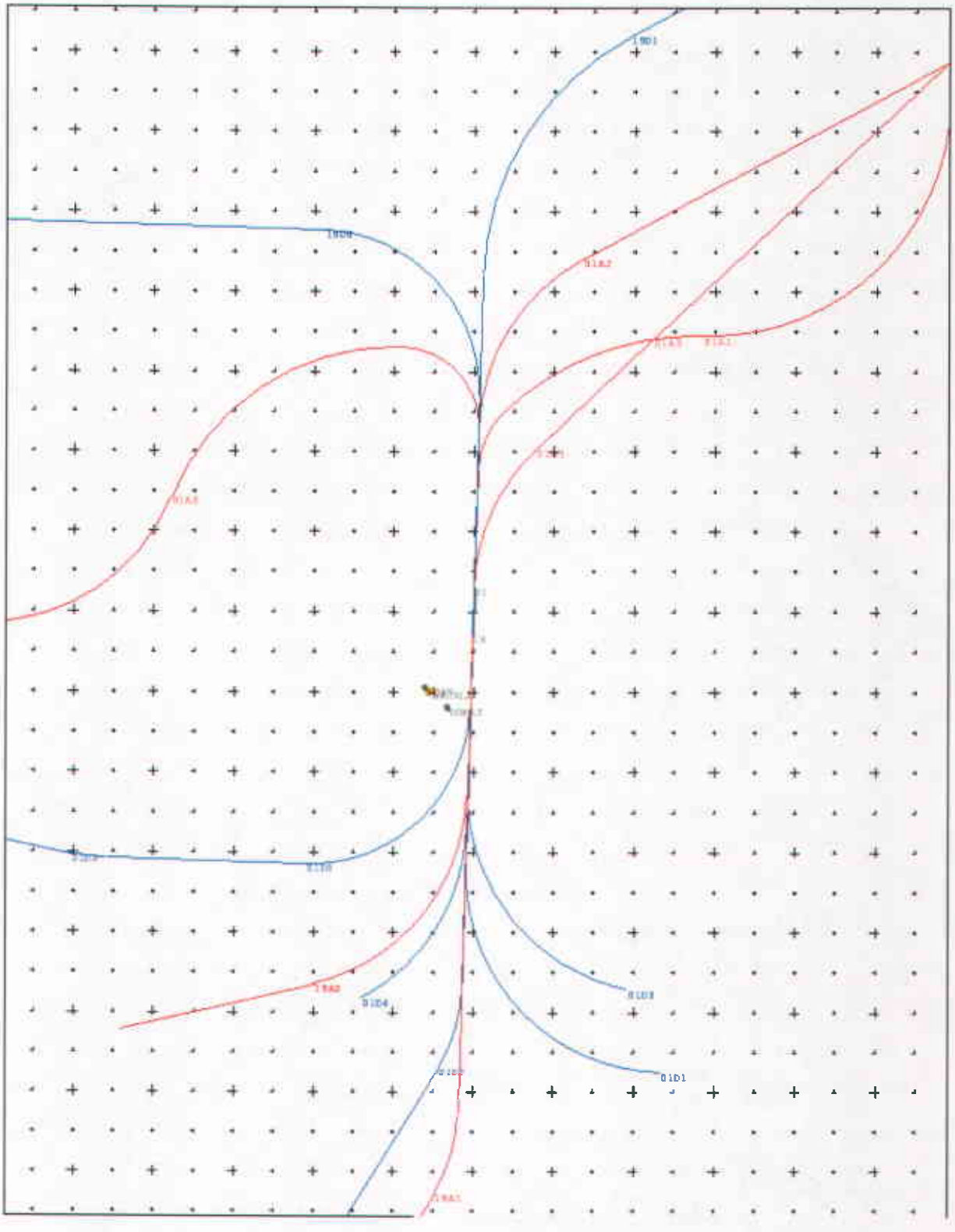
AIRPORTS DE MOZAMBIQUE

NACALA INTERNATIONAL AIRPORT

AAROTEC

INTEGRATED NOISE MODEL
FOR DEVEOPMENT YEAR 2028

SQ.MI	9.74	4.55	2.07	0.83	0.36	0.14	0.07
DNL	55	60	65	70	75	80	85



Flights Paths for 2028 Case Study at Nacala Airport

INM 6.2 This function to open the Case Select where selecting a case identifier and pressing OK causes INM to write the FLIGHT.TXT file to the case subdirectory. This large text file contains flight path data that were used to compute noise for the case.

```
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  max_level         = 85.0
  run_type          = S
  metric_id         = DNL
  fq_type           = A
  metric_type       = E
  metric_weight     = 1.00, 1.00, 10.00
  metric_time       = 49.37
  do_humidity       = 1
  do_terrain        = N
  nodata_terrain_elev = -9999
  ground_type       = S
  terrain_dir       = S:\8028 Mozambique\Noise Study\FAA INM\INM 62a\
  ground_file       =
  ambient_file      =
  do_contour_grid   = 0
  do_standard_grids = 1
  do_detailed_grids = 0
  do_100_percent    = 0
  do_metric         = 1
  numb_ngroup       = 6
  numb_noise        = 66
  numb_acft         = 15
```

```
  numb_grid          = 3
  numb_pop_pts       = 2
  numb_loc_pts       = 3
  numb_scr_pts       = 0
NOISE
  0  2JT8DW A  3000.0 A 102.3  97.2  92.9  88.5  82.8  75.6  70.9  65.4  58.8  51.8
                        102.6  94.6  88.6  82.3  73.8  64.5  58.0  51.0  42.8  34.4
  1  2JT8DW A  6000.0 A 106.1 100.5  96.7  93.0  87.2  80.9  76.1  70.7  64.1  56.9
                        105.4  97.9  91.5  85.8  77.2  68.5  61.9  55.1  47.1  38.5
  2  2JT8DW A  8000.0 D 108.8 103.9 100.5  96.8  91.5  85.7  80.5  75.1  68.9  62.0
                        108.6 100.7  95.6  89.9  81.8  73.2  66.5  59.9  52.0  43.8
  3  2JT8DW A 10000.0 D 111.4 107.2 104.3 101.1  95.7  89.5  85.0  79.8  73.5  66.7
                        111.6 104.3  99.5  94.6  86.3  77.7  71.8  64.9  57.2  48.9
  4  2JT8DW A 12000.0 D 115.1 111.1 108.4 105.5 100.2  94.3  89.9  85.0  78.8  72.1
                        115.9 108.9 104.3  99.4  91.1  82.8  76.8  70.1  62.8  54.6
  5  2JT8DW A 14000.0 D 119.8 115.9 113.3 110.5 105.4  99.7  95.3  90.3  84.5  78.4
                        120.8 113.4 109.4 104.5  96.4  88.2  82.3  75.8  68.6  60.9
  6  2JT8DW P  3000.0 A 107.0 102.4  98.7  94.4  87.0  78.6  73.0  66.4  59.0  49.4
                        114.6 107.2 101.7  95.5  85.3  74.1  66.7  58.2  48.9  37.5
  7  2JT8DW P  6000.0 A 110.3 105.8 102.1  97.9  91.0  83.0  77.3  71.0  63.3  54.1
                        117.9 110.6 105.1  99.0  89.3  78.5  71.0  62.8  53.2  42.2
  8  2JT8DW P  8000.0 D 112.9 108.4 104.7 100.9  94.0  86.2  80.6  74.7  67.6  59.3
                        120.5 113.2 107.7 102.0  92.3  81.7  74.3  66.5  57.5  47.4
  9  2JT8DW P 10000.0 D 115.7 111.5 108.0 104.3  98.0  90.8  85.9  80.3  73.8  66.1
                        123.3 116.3 111.0 105.4  96.3  86.3  79.6  72.1  63.7  54.2
 10  2JT8DW P 12000.0 D 119.3 115.2 112.0 108.6 102.8  96.1  91.8  86.5  80.5  73.5
                        126.9 120.0 115.0 109.7 101.1  91.6  85.5  78.3  70.4  61.6
 11  2JT8DW P 14000.0 D 123.9 119.9 117.1 113.0 108.0 101.7  97.3  92.9  87.5  81.1
                        131.5 124.7 120.1 114.1 106.3  97.2  91.0  84.7  77.4  69.2
 12  JT9DFL A  8000.0 A 102.3  97.8  94.3  90.5  84.4  77.7  72.9  67.3  60.7  53.3
                        103.0  95.5  90.2  84.3  75.1  66.0  59.7  52.6  44.5  35.6
 13  JT9DFL A 16000.0 A 106.3 101.8  98.3  94.5  88.4  81.7  76.9  71.3  64.7  57.3
                        107.1  99.6  94.3  88.4  79.2  70.1  63.8  56.7  48.6  39.7
 14  JT9DFL A 24000.0 D 109.4 105.1 101.7  98.0  92.2  85.8  81.2  75.9  69.7  62.8
                        110.6 103.1  97.8  92.1  83.3  74.5  68.3  61.5  53.7  45.4
 15  JT9DFL A 32000.0 D 111.8 107.4 104.1 100.5  94.9  88.7  84.2  79.1  73.1  66.5
```

					113.5	105.9	100.6	95.1	86.5	77.9	71.9	65.3	57.7	49.7
16	JT9DFL	A	40000.0	D	113.8	109.4	106.1	102.5	96.9	90.7	86.2	81.1	75.1	68.5
					115.7	108.1	102.8	97.3	88.7	80.1	74.1	67.5	59.9	51.9
17	JT9DFL	P	8000.0	A	106.9	102.2	98.4	93.8	85.4	77.4	71.9	65.7	58.2	49.3
					114.5	107.0	101.4	94.9	83.7	72.9	65.6	57.5	48.1	37.4
18	JT9DFL	P	16000.0	A	112.6	107.9	104.1	99.5	91.1	83.1	77.6	71.4	63.9	55.0
					120.2	112.7	107.1	100.6	89.4	78.6	71.3	63.2	53.8	43.1
19	JT9DFL	P	24000.0	D	116.3	111.7	108.1	103.9	96.1	89.2	83.7	77.6	70.9	63.1
					123.9	116.5	111.1	105.0	94.4	84.7	77.4	69.4	60.8	51.2
20	JT9DFL	P	32000.0	D	118.6	114.0	110.5	106.5	99.5	92.5	87.1	81.0	74.7	67.4
					126.2	118.8	113.5	107.6	97.8	88.0	80.8	72.8	64.6	55.5
21	JT9DFL	P	40000.0	D	120.6	116.0	112.5	108.5	101.0	94.5	89.1	83.0	76.7	69.4
					128.2	120.8	115.5	109.6	99.3	90.0	82.8	74.8	66.6	57.5
22	A310	A	3000.0	A	96.0	91.1	88.1	84.8	79.5	73.4	68.7	63.3	56.8	50.1
					92.9	86.3	81.8	76.9	68.9	59.5	52.1	44.4	36.6	28.4
23	A310	A	12000.0	A	98.7	93.6	90.4	87.0	81.6	75.5	70.8	65.4	59.0	52.2
					95.5	88.1	83.1	77.8	69.5	60.6	54.1	46.9	38.9	30.5
24	A310	A	20000.0	D	102.7	98.3	94.5	90.5	83.8	76.5	71.6	66.1	59.5	52.7
					101.6	93.8	88.6	82.7	73.0	63.1	56.1	48.3	40.1	31.8
25	A310	A	30000.0	D	103.7	99.2	95.8	92.3	86.7	80.4	75.8	70.4	64.3	57.6
					103.4	95.3	89.9	84.2	75.4	66.1	59.6	52.5	44.5	36.1
26	A310	A	40000.0	D	104.5	100.4	97.6	94.4	89.2	83.4	79.0	73.9	68.0	61.4
					104.4	96.9	91.9	86.6	78.3	69.2	62.7	55.7	48.0	39.7
27	A310	A	50000.0	D	108.0	103.9	101.2	98.2	93.3	87.8	83.6	78.6	72.9	66.4
					108.8	101.6	96.7	91.5	83.0	73.7	67.7	61.0	53.3	44.8
28	A310	P	3000.0	A	101.0	95.2	91.4	87.2	81.0	74.1	68.4	61.8	53.3	41.4
					108.7	101.5	96.5	91.1	82.2	71.9	64.2	55.8	44.4	30.6
29	A310	P	12000.0	A	103.5	97.6	93.5	89.2	82.7	75.7	70.5	63.7	55.4	45.1
					110.5	102.6	96.9	90.8	80.7	70.8	64.3	55.8	46.1	34.4
30	A310	P	20000.0	D	109.4	104.8	100.5	96.0	87.7	78.3	72.8	65.5	56.8	45.9
					119.8	112.0	106.4	100.2	89.4	75.6	66.9	58.6	48.0	36.1
31	A310	P	30000.0	D	109.6	104.7	100.8	96.4	89.1	81.7	76.7	70.5	62.5	52.5
					118.6	110.5	104.6	98.0	87.7	77.1	70.8	63.0	52.9	42.0
32	A310	P	40000.0	D	109.5	104.9	101.5	97.7	91.3	85.0	80.4	74.3	67.3	58.2
					120.5	112.3	106.4	100.6	90.5	80.9	74.2	66.3	57.3	47.0
33	A310	P	50000.0	D	112.8	108.3	105.1	101.8	96.1	90.2	85.8	79.6	73.1	65.5

					124.6	117.2	111.9	106.2	96.6	86.2	80.8	72.6	64.1	54.1
34	V2527A	A	2000.0	A	93.0	88.1	84.9	81.5	76.0	69.7	65.0	59.8	53.6	46.8
					88.8	81.6	76.8	71.7	63.6	55.0	48.7	41.6	33.8	25.5
35	V2527A	A	2700.0	A	93.3	88.5	85.2	81.8	76.3	70.1	65.4	60.0	53.9	47.2
					89.0	81.7	76.9	71.8	63.9	55.2	48.9	41.9	34.1	25.9
36	V2527A	A	6000.0	A	95.9	90.9	87.6	84.1	78.5	72.3	67.6	62.2	56.2	49.5
					92.4	84.8	79.7	74.6	66.6	57.9	51.5	44.3	36.2	27.9
37	V2527A	A	10000.0	D	95.0	90.2	86.8	83.5	78.1	71.8	67.2	61.9	55.9	49.4
					94.8	86.3	80.5	74.8	66.5	57.6	51.1	44.0	36.2	28.2
38	V2527A	A	14000.0	D	98.3	93.9	90.9	87.6	82.1	75.8	71.1	65.6	59.4	52.8
					96.7	88.6	83.5	78.4	70.5	61.7	55.3	48.1	40.1	31.8
39	V2527A	A	19000.0	D	102.5	98.4	95.5	92.3	87.2	81.1	76.7	71.5	65.7	59.4
					101.2	93.9	89.0	84.0	76.1	67.3	61.1	54.1	46.3	38.2
40	V2527A	A	23000.0	D	104.6	100.7	98.0	95.0	90.0	84.3	80.0	75.1	69.5	63.3
					104.0	96.9	92.2	87.3	79.4	70.8	64.7	57.9	50.3	42.0
41	V2527A	P	2000.0	A	97.2	91.6	87.5	83.1	76.4	69.4	63.2	56.4	47.4	34.4
					106.0	98.3	92.8	86.5	76.1	66.1	57.4	49.4	38.9	25.4
42	V2527A	P	2700.0	A	97.7	91.9	87.9	83.4	76.8	69.8	63.7	56.8	47.7	35.0
					105.3	97.5	91.9	85.6	75.0	66.0	57.8	49.6	39.5	25.7
43	V2527A	P	6000.0	A	100.0	94.2	90.2	85.8	79.1	71.9	66.3	59.8	51.2	39.5
					108.2	99.9	93.7	86.7	77.5	67.2	60.6	52.6	42.7	29.4
44	V2527A	P	10000.0	D	100.5	94.7	90.8	86.6	80.1	72.5	67.2	60.6	51.1	39.5
					113.0	104.5	98.0	90.4	80.4	68.7	61.4	53.8	43.1	30.2
45	V2527A	P	14000.0	D	103.7	98.6	94.8	90.7	84.0	76.4	71.2	64.5	56.5	45.2
					113.5	104.1	97.3	91.2	82.0	71.6	65.3	58.0	48.4	35.7
46	V2527A	P	19000.0	D	106.7	102.2	98.4	94.7	88.7	82.1	77.6	71.6	64.3	55.0
					116.2	108.8	103.6	97.8	88.0	78.3	72.7	65.0	55.7	44.9
47	V2527A	P	23000.0	D	108.2	104.1	101.0	97.6	91.9	85.9	81.6	75.7	68.8	60.6
					118.4	110.9	105.3	99.6	91.1	82.6	76.9	69.5	59.8	49.8
48	CF565C	A	3000.0	A	95.6	90.6	87.6	84.3	79.0	73.1	68.5	63.4	57.6	50.9
					91.3	83.7	78.7	73.8	66.0	57.5	51.5	44.8	37.3	29.3
49	CF565C	A	5000.0	A	96.6	91.2	87.9	84.5	79.2	73.3	68.7	63.6	57.8	51.5
					92.0	84.1	79.0	73.9	66.2	57.7	51.7	44.9	37.3	29.4
50	CF565C	A	12500.0	D	98.8	92.6	88.7	84.8	78.6	71.9	67.1	61.6	55.4	48.5
					98.9	89.4	82.8	76.4	67.3	57.8	51.3	44.2	36.3	27.7
51	CF565C	A	20000.0	D	105.3	99.9	96.4	92.9	87.3	81.0	76.4	70.9	64.7	57.8

					103.4	95.3	89.8	83.9	75.3	66.2	59.9	53.0	45.0	36.3
52	CF565C	A	27500.0	D	108.0	103.5	100.5	97.4	92.1	86.2	81.7	76.2	70.7	64.6
					106.9	99.4	94.4	89.3	81.0	71.9	65.4	58.3	50.2	41.5
53	CF565C	P	3000.0	A	101.4	95.6	91.8	87.7	81.4	73.8	68.1	61.6	52.9	42.4
					110.3	101.9	95.7	89.1	80.9	68.5	61.8	53.1	43.4	31.8
54	CF565C	P	5000.0	A	101.3	95.1	90.8	86.7	80.4	73.4	68.0	61.6	53.2	43.4
					108.2	100.0	93.7	87.1	77.9	67.9	61.1	53.2	43.5	32.9
55	CF565C	P	12500.0	D	104.7	99.0	94.7	89.9	82.0	73.3	67.8	60.2	51.1	39.9
					115.3	106.1	99.1	92.4	81.5	69.4	62.6	53.2	42.8	31.7
56	CF565C	P	20000.0	D	111.0	105.0	101.0	96.5	89.2	82.3	77.5	71.0	63.4	53.5
					119.7	111.7	105.9	99.2	87.1	77.7	71.4	63.2	54.2	42.8
57	CF565C	P	27500.0	D	113.4	108.5	105.2	101.3	94.9	88.3	83.4	77.4	70.3	62.4
					122.8	115.2	109.9	104.0	94.1	83.6	77.9	69.2	60.9	51.9
58	CJ610	A	700.0	A	100.8	96.4	93.3	89.9	84.0	77.0	71.5	65.1	57.8	49.6
					98.5	91.9	87.3	82.4	74.3	65.0	58.0	50.1	41.3	31.6
59	CJ610	A	1800.0	A	119.3	114.8	111.6	108.0	101.9	94.5	88.6	81.6	73.4	63.9
					117.1	110.3	105.6	100.5	92.2	82.5	75.1	66.7	57.0	46.0
60	CJ610	A	1800.0	D	119.3	114.8	111.6	108.0	101.9	94.5	88.6	81.6	73.4	63.9
					117.1	110.3	105.6	100.5	92.2	82.5	75.1	66.7	57.0	46.0
61	CJ610	A	2600.0	D	124.7	119.7	116.0	112.0	105.3	97.5	91.3	84.1	75.7	66.1
					122.2	115.0	109.8	104.3	95.3	85.3	77.6	68.9	59.0	47.9
62	CJ610	P	700.0	A	102.9	98.1	94.5	90.6	83.7	75.5	69.5	62.5	54.6	44.6
					110.5	102.9	97.5	91.7	82.0	71.0	63.2	54.3	44.5	32.7
63	CJ610	P	1800.0	A	121.7	116.7	112.9	108.7	101.6	93.8	87.9	80.9	72.6	63.0
					129.3	121.5	115.9	109.8	99.9	89.3	81.6	72.7	62.5	51.1
64	CJ610	P	1800.0	D	121.7	116.7	112.9	108.7	101.6	93.8	87.9	80.9	72.6	63.0
					129.3	121.5	115.9	109.8	99.9	89.3	81.6	72.7	62.5	51.1
65	CJ610	P	2600.0	D	127.6	121.9	117.7	112.8	104.2	96.0	89.9	82.6	74.0	64.2
					135.2	126.7	120.7	113.9	102.5	91.5	83.6	74.4	63.9	52.3

AIRCRAFT OPERATIONS
0

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acft_id     = B737
eng_type    = J
owner_cat   = C
op_type     = A
numb_ops    = 4.0000
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  frst_a_nois = 0
  numb_a_nois = 6
  frst_p_nois = 6
  numb_p_nois = 6
  model_type  = I
  spect_nums  = 201, 101, 0
  flt_path    = A-19-19A0-3-STANDARD-1
  numb_segs   = 21
  seg  start-x   start-y  start-z   unit-x  unit-y  unit-z   length   speed  d.spd   thrust    d.thr  op
   0  -72162.9  -65987.5   6000.0   0.9714  0.2314 -0.0523   6368.6   282.5  -11.0    791.2    108.5   A
   1  -65976.2  -64513.6   5666.7   0.9714  0.2314 -0.0523   6368.6   271.5  -11.0    899.7    108.5   A
   2  -59789.4  -63039.7   5333.4   0.9714  0.2314 -0.0523   6368.6   260.5  -11.0   1008.2    108.5   A
   3  -53602.7  -61565.8   5000.1   0.9714  0.2314 -0.0523   7605.6   249.5  -13.1   1116.7    129.6   A
   4  -46214.3  -59805.7   4602.0   0.9714  0.2314 -0.0523   7605.6   236.3  -13.1   1246.3    129.6   A
   5  -38826.0  -58045.5   4204.0   0.9714  0.2314 -0.0523   7605.6   223.2  -13.1   1375.9    129.6   A
   6  -31437.6  -56285.3   3805.9   0.9714  0.2314 -0.0523   7605.6   210.1  -13.1   1505.5    129.6   A
   7  -24049.2  -54525.2   3407.9   0.9197  0.3891 -0.0523   3896.9   196.9   -6.7   1635.0     66.4   A
   8  -20465.2  -53008.8   3203.9   0.9197  0.3891 -0.0523   3896.9   190.2   -6.7   1701.4     66.4   A
   9  -16881.2  -51492.5   3000.0   0.9197  0.3891 -0.0523   4152.9   183.5   -6.0   1767.8    178.7   A
  10  -13061.7  -49876.6   2782.7   0.6569  0.7522 -0.0523   5973.4   177.4   -8.7   1946.5    257.1   A
  11   -9137.8  -45383.6   2470.0   0.6569  0.7522 -0.0523   5973.4   168.8   -8.7   2203.6    257.1   A
  12   -5213.9  -40890.6   2157.4   0.4260  0.9032 -0.0523   7964.5   160.1  -11.5   2460.6    342.7   A
  13   -1820.7  -33697.2   1740.6   0.1381  0.9890 -0.0523   4596.7   148.6   -6.7   2803.4    197.8   A
  14   -1186.1  -29150.8   1500.0   0.1381  0.9890 -0.0523   3367.8   141.9   -1.5   3001.2    174.0   A
  15    -721.2  -25819.9   1323.7   0.0279  0.9982 -0.0523   6185.9   140.4   -2.7   3175.2    319.6   A
  16    -548.7  -19644.9   1000.0   0.0279  0.9982 -0.0523  19107.4   137.7   -2.0   3494.8   -124.8   A
  17     -16.0    -571.2      0.0   0.0279  0.9996  0.0000    255.6   135.7   -6.9   3370.0   5330.0   A
  18      -8.8    -315.7      0.0   0.0279  0.9996  0.0000   1150.2   128.8  -48.9   8700.0  -3625.0   D
  19      23.3     834.1      0.0   0.0279  0.9996  0.0000   1150.2    79.9  -48.9   5075.0  -3625.0   D
  20      55.4    1983.8      0.0   0.0279  0.9996  0.0000      1.0    30.9    0.0   1450.0      0.0   A
1
  acft_id     = B737
  eng_type    = J
  owner_cat   = C
  op_type     = D
  numb_ops    = 4.0000, 0.0000, 0.0000
```

```
frst_a_nois = 0
numb_a_nois = 6
frst_p_nois = 6
numb_p_nois = 6
model_type  = I
spect_nums  = 201, 101, 0
flt_path    = D-19-19D0-3-STANDARD-1
numb_segs   = 26
```

seg	start-x	start-y	start-z	unit-x	unit-y	unit-z	length	speed	d.spd	thrust	d.thr	op
0	-42.6	-1524.9	0.0	0.0279	0.9996	0.0000	523.8	35.0	17.6	13837.1	-195.7	D
1	-28.0	-1001.3	0.0	0.0279	0.9996	0.0000	523.8	52.6	17.6	13641.4	-195.7	D
2	-13.3	-477.8	0.0	0.0279	0.9996	0.0000	523.8	70.2	17.6	13445.6	-195.7	D
3	1.3	45.8	0.0	0.0279	0.9996	0.0000	523.8	87.7	17.6	13249.9	-195.7	D
4	15.9	569.4	0.0	0.0279	0.9996	0.0000	523.8	105.3	17.6	13054.1	-195.7	D
5	30.5	1093.0	0.0	0.0279	0.9996	0.0000	523.8	122.9	17.6	12858.4	-195.7	D
6	45.2	1616.6	0.0	0.0272	0.9748	0.2212	452.0	140.5	0.2	12662.6	-3.0	D
7	57.5	2057.2	100.0	0.0272	0.9748	0.2212	1356.0	140.7	0.6	12659.7	-8.9	D
8	94.4	3379.1	400.0	0.0272	0.9748	0.2212	2712.0	141.3	1.3	12650.7	-17.8	D
9	168.2	6022.9	1000.0	0.0276	0.9885	0.1485	2058.4	142.6	11.0	12632.9	-94.2	D
10	225.1	8057.7	1305.6	0.0278	0.9947	0.0990	3240.4	153.6	27.2	12538.7	-225.5	D
11	315.1	11280.9	1626.5	0.0279	0.9982	0.0523	1001.4	180.7	8.3	12313.2	-985.0	D
12	343.0	12280.5	1678.8	0.0279	0.9982	0.0523	2034.0	189.1	16.9	11328.2	-158.5	D
13	399.7	14311.0	1785.2	0.0279	0.9982	0.0523	2034.0	206.0	16.9	11169.7	-158.5	D
14	456.4	16341.4	1891.6	0.0275	0.9848	0.1715	6463.6	222.9	3.8	11011.1	-32.2	D
15	634.2	22706.7	3000.0	0.0279	0.9987	0.0423	3588.6	226.6	22.2	10979.0	-163.2	D
16	734.3	26290.7	3151.8	0.0279	0.9987	0.0423	3588.6	248.8	22.2	10815.7	-163.2	D
17	834.4	29874.7	3303.6	0.0276	0.9887	0.1473	5100.5	271.0	3.2	10652.5	-23.1	D
18	975.3	34917.6	4055.0	-0.1365	0.9796	0.1473	9649.6	274.2	6.0	10629.5	-43.7	D
19	-341.8	44370.6	5476.7	-0.5512	0.8213	0.1473	158.1	280.2	0.1	10585.8	-0.7	D
20	-429.0	44500.5	5500.0	-0.5525	0.8233	0.1302	9468.6	280.3	5.5	10585.1	-40.1	D
21	-5660.7	52295.5	6733.1	-0.7911	0.5976	0.1302	5888.4	285.8	3.4	10545.0	-24.9	D
22	-10319.2	55814.5	7500.0	-0.7928	0.5989	0.1131	3730.1	289.2	2.0	10520.1	-14.5	D
23	-13276.4	58048.4	7922.0	-0.9749	0.1918	0.1131	9606.0	291.1	5.1	10505.6	-37.4	D
24	-22641.1	59891.1	9008.8	-0.9932	0.0277	0.1131	8760.7	296.2	4.6	10468.1	-34.1	D
25	-31342.2	60134.2	10000.0	-0.9932	0.0277	0.1131	1.0	300.8	0.0	10434.0	0.0	D

2

```
acft_id     = B737
eng_type    = J
owner_cat   = C
op_type     = D
numb_ops    = 4.0000, 0.0000, 0.0000
frst_a_nois = 0
numb_a_nois = 6
frst_p_nois = 6
numb_p_nois = 6
model_type  = I
spect_nums  = 201, 101, 0
flt_path    = D-19-19D1-3-STANDARD-1
numb_segs   = 25
```

seg	start-x	start-y	start-z	unit-x	unit-y	unit-z	length	speed	d.spd	thrust	d.thr	op
0	-42.6	-1524.9	0.0	0.0279	0.9996	0.0000	523.8	35.0	17.6	13837.1	-195.7	D
1	-28.0	-1001.3	0.0	0.0279	0.9996	0.0000	523.8	52.6	17.6	13641.4	-195.7	D
2	-13.3	-477.8	0.0	0.0279	0.9996	0.0000	523.8	70.2	17.6	13445.6	-195.7	D
3	1.3	45.8	0.0	0.0279	0.9996	0.0000	523.8	87.7	17.6	13249.9	-195.7	D
4	15.9	569.4	0.0	0.0279	0.9996	0.0000	523.8	105.3	17.6	13054.1	-195.7	D
5	30.5	1093.0	0.0	0.0279	0.9996	0.0000	523.8	122.9	17.6	12858.4	-195.7	D
6	45.2	1616.6	0.0	0.0272	0.9748	0.2212	452.0	140.5	0.2	12662.6	-3.0	D
7	57.5	2057.2	100.0	0.0272	0.9748	0.2212	1356.0	140.7	0.6	12659.7	-8.9	D
8	94.4	3379.1	400.0	0.0272	0.9748	0.2212	2712.0	141.3	1.3	12650.7	-17.8	D
9	168.2	6022.9	1000.0	0.0276	0.9885	0.1485	2058.4	142.6	11.0	12632.9	-94.2	D
10	225.1	8057.7	1305.6	0.0278	0.9947	0.0990	3240.4	153.6	27.2	12538.7	-225.5	D
11	315.1	11280.9	1626.5	0.0279	0.9982	0.0523	1001.4	180.7	8.3	12313.2	-985.0	D
12	343.0	12280.5	1678.8	0.0279	0.9982	0.0523	2034.0	189.1	16.9	11328.2	-158.5	D
13	399.7	14311.0	1785.2	0.0279	0.9982	0.0523	2034.0	206.0	16.9	11169.7	-158.5	D
14	456.4	16341.4	1891.6	0.0275	0.9848	0.1715	6463.6	222.9	3.8	11011.1	-32.2	D
15	634.2	22706.7	3000.0	0.0279	0.9987	0.0423	3588.6	226.6	22.2	10979.0	-163.2	D
16	734.3	26290.7	3151.8	0.0279	0.9987	0.0423	3588.6	248.8	22.2	10815.7	-163.2	D
17	834.4	29874.7	3303.6	0.0276	0.9887	0.1473	7454.1	271.0	4.6	10652.5	-33.7	D
18	1040.3	37244.6	4401.8	0.0276	0.9887	0.1473	7454.1	275.7	4.6	10618.8	-33.7	D
19	1246.1	44614.5	5500.0	0.0277	0.9911	0.1302	8600.8	280.3	5.0	10585.1	-36.4	D
20	1484.2	53138.8	6620.1	0.2454	0.9606	0.1302	6756.1	285.3	3.9	10548.7	-28.6	D
21	3142.4	59628.9	7500.0	0.2460	0.9627	0.1131	7836.1	289.2	4.1	10520.1	-30.5	D

22	5069.8	67172.3	8386.6	0.2460	0.9627	0.1131	7836.1	293.3	4.1	10489.6	-30.5	D
23	6997.2	74715.8	9273.1	0.7484	0.6536	0.1131	6424.6	297.4	3.4	10459.0	-25.0	D
24	11805.0	78914.8	10000.0	0.7484	0.6536	0.1131	1.0	300.8	0.0	10434.0	0.0	D

3

```
acft_id     = B74710Q
eng_type    = J
owner_cat   = C
op_type     = A
numb_ops    = 1.0000, 0.0000, 0.0000
frst_a_nois = 12
numb_a_nois = 5
frst_p_nois = 17
numb_p_nois = 5
model_type  = I
spect_nums  = 207, 107, 0
flt_path    = A-01-01A0-3-STANDARD-1
numb_segs   = 25
```

seg	start-x	start-y	start-z	unit-x	unit-y	unit-z	length	speed	d.spd	thrust	d.thr	op
0	-63870.8	-1830.0	6000.0	0.9695	0.2394	-0.0523	1740.8	282.5	-3.3	983.9	150.6	A
1	-62183.0	-1413.3	5908.9	0.8382	0.5429	-0.0523	5973.4	279.1	-11.4	1134.5	516.7	A
2	-57176.3	1829.6	5596.3	0.8382	0.5429	-0.0523	5973.4	267.7	-11.4	1651.2	516.7	A
3	-52169.6	5072.6	5283.6	0.5163	0.8548	-0.0523	5973.4	256.3	-11.4	2167.9	516.7	A
4	-49085.6	10178.7	4971.0	0.5163	0.8548	-0.0523	5973.4	244.8	-11.4	2684.6	516.7	A
5	-46001.5	15284.8	4658.4	0.4842	0.8734	-0.0523	5575.2	233.4	-10.7	3201.4	482.3	A
6	-43301.7	20153.9	4366.6	0.4842	0.8734	-0.0523	5575.2	222.7	-10.7	3683.6	482.3	A
7	-40602.0	25023.1	4074.8	0.7559	0.6526	-0.0523	5575.2	212.0	-10.7	4165.9	482.3	A
8	-36387.8	28661.5	3783.1	0.7559	0.6526	-0.0523	5575.2	201.3	-10.7	4648.2	482.3	A
9	-32173.7	32300.0	3491.3	0.8976	0.4377	-0.0523	4693.5	190.6	-9.0	5130.5	406.0	A
10	-27960.7	34354.1	3245.6	0.8976	0.4377	-0.0523	4693.5	181.7	-9.0	5536.5	406.0	A
11	-23747.8	36408.3	3000.0	0.8976	0.4377	-0.0523	1763.4	172.7	-0.6	5942.5	124.7	A
12	-22164.9	37180.1	2907.7	0.9935	0.1010	-0.0523	11150.3	172.1	-3.6	6067.2	788.6	A
13	-11087.0	38306.7	2324.1	0.9798	-0.1928	-0.0523	4778.7	168.5	-1.5	6855.7	338.0	A
14	-6404.6	37385.4	2074.0	0.7968	-0.6019	-0.0523	4778.7	167.0	-1.5	7193.7	338.0	A
15	-2596.8	34508.9	1823.9	0.5565	-0.8292	-0.0523	4778.7	165.5	-1.5	7531.7	338.0	A
16	62.6	30546.4	1573.8	0.1378	-0.9891	-0.0523	1411.0	164.0	-0.4	7869.6	99.8	A
17	257.1	29150.8	1500.0	0.1378	-0.9891	-0.0523	3367.7	163.5	-4.5	7969.4	1505.3	A

18	721.2	25819.9	1323.7	-0.0279	-0.9982	-0.0523	6186.0	159.0	-8.2	9474.7	2765.0	A
19	548.7	19644.8	1000.0	-0.0279	-0.9982	-0.0523	19107.3	150.8	-2.2	12239.6	-437.0	A
20	15.9	571.1	0.0	-0.0279	-0.9996	0.0000	462.6	148.6	-7.6	11802.7	15497.3	A
21	3.0	108.7	0.0	-0.0279	-0.9996	0.0000	1387.8	140.9	-36.7	27300.0	-7583.3	D
22	-35.7	-1278.6	0.0	-0.0279	-0.9996	0.0000	1387.8	104.3	-36.7	19716.7	-7583.3	D
23	-74.5	-2665.8	0.0	-0.0279	-0.9996	0.0000	1387.8	67.6	-36.7	12133.3	-7583.3	D
24	-113.2	-4053.1	0.0	-0.0279	-0.9996	0.0000	1.0	30.9	0.0	4550.0	0.0	A

4

```
acft_id     = B74710Q
eng_type    = J
owner_cat   = C
op_type     = D
numb_ops    = 1.0000, 0.0000, 0.0000
frst_a_nois = 12
numb_a_nois = 5
frst_p_nois = 17
numb_p_nois = 5
model_type  = I
spect_nums  = 207, 107, 0
flt_path    = D-01-01D0-3-STANDARD-1
numb_segs   = 30
```

seg	start-x	start-y	start-z	unit-x	unit-y	unit-z	length	speed	d.spd	thrust	d.thr	op
0	42.6	1524.9	0.0	-0.0279	-0.9996	0.0000	669.1	35.0	19.3	42908.8	-1233.2	D
1	23.9	856.1	0.0	-0.0279	-0.9996	0.0000	669.1	54.3	19.3	41675.6	-1233.2	D
2	5.2	187.3	0.0	-0.0279	-0.9996	0.0000	669.1	73.6	19.3	40442.4	-1233.2	D
3	-13.5	-481.6	0.0	-0.0279	-0.9996	0.0000	669.1	92.9	19.3	39209.2	-1233.2	D
4	-32.1	-1150.4	0.0	-0.0279	-0.9996	0.0000	669.1	112.3	19.3	37976.0	-1233.2	D
5	-50.8	-1819.2	0.0	-0.0279	-0.9996	0.0000	669.1	131.6	19.3	36742.9	-1233.2	D
6	-69.5	-2488.1	0.0	-0.0274	-0.9792	0.2010	497.6	150.9	0.2	35509.7	33.1	D
7	-83.1	-2975.3	100.0	-0.0274	-0.9792	0.2010	1492.9	151.1	0.7	35542.7	99.2	D
8	-123.9	-4437.2	400.0	-0.0274	-0.9792	0.2010	2985.7	151.8	1.4	35641.9	198.4	D
9	-205.6	-7360.8	1000.0	-0.0277	-0.9917	0.1256	3742.5	153.2	16.9	35840.3	-606.7	D
10	-309.3	-11072.2	1470.2	-0.0277	-0.9917	0.1256	3742.5	170.0	16.9	35233.6	-606.7	D
11	-412.9	-14783.6	1940.4	-0.0279	-0.9984	0.0497	1001.2	186.9	5.7	34627.0	-4847.7	D
12	-440.8	-15783.2	1990.1	-0.0279	-0.9984	0.0497	914.6	192.6	5.2	29779.3	-226.3	D
13	-466.3	-16696.3	2035.6	-0.1928	-0.9800	0.0497	2864.0	197.9	16.4	29553.0	-708.7	D

14	-1018.6	-19503.0	2178.0	-0.1928	-0.9800	0.0497	2864.0	214.3	16.4	28844.3	-708.7	D
15	-1570.9	-22309.6	2320.5	-0.1909	-0.9704	0.1480	3866.0	230.7	2.0	28135.6	140.1	D
16	-2309.0	-26061.1	2892.8	-0.5961	-0.7891	0.1480	724.0	232.7	0.4	28275.7	26.2	D
17	-2740.6	-26632.4	3000.0	-0.6023	-0.7972	0.0412	3721.5	233.1	19.0	28301.9	-703.5	D
18	-4981.9	-29599.3	3153.4	-0.6023	-0.7972	0.0412	3721.5	252.1	19.0	27598.4	-703.5	D
19	-7223.2	-32566.2	3306.7	-0.5978	-0.7913	0.1281	1403.3	271.0	0.8	26894.9	38.2	D
20	-8062.0	-33676.7	3486.5	-0.8235	-0.5527	0.1281	9623.6	271.8	5.2	26933.1	262.1	D
21	-15986.9	-38995.6	4719.4	-0.9823	-0.1369	0.1281	6092.5	277.0	3.3	27195.2	165.9	D
22	-21971.4	-39829.4	5500.0	-0.9837	-0.1371	0.1168	3526.2	280.3	1.8	27361.1	71.7	D
23	-25439.9	-40312.7	5911.9	-0.9928	0.0277	0.1168	13596.7	282.1	7.0	27432.7	276.3	D
24	-38938.3	-39935.7	7500.0	-0.9941	0.0278	0.1047	8485.1	289.2	4.1	27709.0	117.8	D
25	-47373.5	-39700.1	8388.2	-0.9941	0.0278	0.1047	8485.1	293.3	4.1	27826.8	117.8	D
26	-55808.6	-39464.5	9276.4	-0.9924	0.0644	0.1047	2665.9	297.4	1.3	27944.5	37.0	D
27	-58454.3	-39292.8	9555.4	-0.9809	0.1639	0.1047	2665.9	298.7	1.3	27981.5	37.0	D
28	-61069.2	-38855.8	9834.5	-0.9742	0.2000	0.1047	1581.1	300.0	0.8	28018.5	21.9	D
29	-62609.5	-38539.7	10000.0	-0.9742	0.2000	0.1047	1.0	300.8	0.0	28040.5	0.0	D

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```
acft_id     = A310
eng_type    = J
owner_cat   = C
op_type     = A
numb_ops    = 1.0000, 0.0000, 0.0000
frst_a_nois = 22
numb_a_nois = 6
frst_p_nois = 28
numb_p_nois = 6
model_type  = I
spect_nums  = 204, 103, 0
flt_path    = A-19-19A0-3-STANDARD-1
numb_segs   = 34
```

seg	start-x	start-y	start-z	unit-x	unit-y	unit-z	length	speed	d.spd	thrust	d.thr	op
0	-98904.8	-72358.4	6000.0	0.9713	0.2314	-0.0554	15076.9	272.3	-3.2	1.0	0.0	A
1	-84260.8	-68869.7	5165.3	0.9713	0.2314	-0.0556	11404.4	269.1	-2.4	1.0	0.0	A
2	-73184.0	-66230.8	4531.4	0.9713	0.2314	-0.0558	9566.8	266.7	-2.1	1.0	0.0	A
3	-63892.2	-64017.2	3997.6	0.9713	0.2314	-0.0559	865.9	264.6	-0.2	1.0	0.0	A
4	-63051.1	-63816.8	3949.2	0.9712	0.2314	-0.0560	9728.1	264.4	-2.0	1.0	0.0	A

5	-53602.7	-61565.8	3404.1	0.9712	0.2314	-0.0560	5754.6	262.4	-1.2	1.0	0.0	A
6	-48013.6	-60234.3	3081.7	0.9712	0.2314	-0.0562	1453.9	261.2	-0.3	1.0	0.0	A
7	-46601.5	-59897.9	3000.0	0.9728	0.2317	0.0000	4889.5	260.9	-13.3	1.0	0.0	A
8	-41845.1	-58764.8	3000.0	0.9728	0.2317	0.0000	4889.5	247.6	-13.3	1.0	0.0	A
9	-37088.7	-57631.6	3000.0	0.9728	0.2317	0.0000	4889.5	234.2	-13.3	1.0	0.0	A
10	-32332.3	-56498.5	3000.0	0.9728	0.2318	0.0000	3155.1	220.9	-10.8	1.0	0.0	A
11	-29263.1	-55767.3	3000.0	0.9728	0.2318	0.0000	338.5	210.1	-2.2	1.0	802.5	A
12	-28933.8	-55688.8	3000.0	0.9728	0.2317	0.0000	5021.3	207.9	-18.3	803.5	192.9	A
13	-24049.2	-54525.2	3000.0	0.9210	0.3896	0.0000	260.6	189.6	-1.0	996.4	10.0	A
14	-23809.2	-54423.6	3000.0	0.9210	0.3896	0.0000	4339.1	188.6	-18.8	1006.4	202.4	A
15	-19813.0	-52732.9	3000.0	0.9210	0.3896	0.0000	3186.1	169.8	-16.0	1208.8	190.0	A
16	-16878.8	-51491.5	3000.0	0.9197	0.3891	-0.0524	490.5	153.8	-1.0	1398.8	11.6	A
17	-16427.7	-51300.7	2974.3	0.9197	0.3891	-0.0523	3279.7	152.8	-10.5	1410.4	123.1	A
18	-13411.3	-50024.5	2802.7	0.9198	0.3889	-0.0523	19.1	142.3	0.0	1533.5	5424.2	A
19	-13393.7	-50017.1	2801.7	0.9197	0.3891	-0.0524	361.0	142.3	-0.0	6957.8	1382.8	A
20	-13061.7	-49876.6	2782.8	0.6569	0.7522	-0.0524	526.5	142.3	-0.1	8340.6	2016.7	A
21	-12715.8	-49480.6	2755.2	0.6569	0.7522	-0.0523	11420.3	142.2	-1.2	10357.3	-223.9	A
22	-5213.9	-40890.6	2157.5	0.4260	0.9032	-0.0523	2098.9	141.0	-0.2	10133.4	-41.1	A
23	-4319.7	-38994.9	2047.7	0.4260	0.9032	-0.0523	5865.6	140.8	-0.7	10092.3	-110.4	A
24	-1820.7	-33697.2	1740.7	0.1381	0.9890	-0.0523	7506.9	140.1	-0.8	9981.9	-141.3	A
25	-784.4	-26272.5	1347.8	0.1381	0.9890	-0.0523	457.6	139.3	-0.0	9840.6	-8.4	A
26	-721.2	-25819.9	1323.8	0.0279	0.9982	-0.0523	12771.7	139.3	-1.4	9832.2	-235.3	A
27	-365.1	-13070.7	655.4	0.0279	0.9982	-0.0523	10700.4	137.9	-1.1	9596.8	-335.3	A
28	-66.7	-2389.1	95.3	0.0279	0.9982	-0.0523	865.8	136.8	-0.1	9261.5	-493.6	A
29	-42.6	-1524.9	50.0	0.0279	0.9982	-0.0523	955.3	136.7	0.0	8768.0	0.0	A
30	-16.0	-571.2	0.0	0.0279	0.9996	0.0000	351.9	136.7	-7.0	8768.0	23032.0	A
31	-6.1	-219.5	0.0	0.0279	0.9996	0.0000	1583.6	129.7	-49.8	31800.0	-13250.0	D
32	38.1	1363.5	0.0	0.0279	0.9996	0.0000	1583.6	79.8	-49.8	18550.0	-13250.0	D
33	82.3	2946.4	0.0	0.0279	0.9996	0.0000	1.0	30.0	0.0	5300.0	0.0	A

6

```
acft_id     = A310
eng_type    = J
owner_cat   = C
op_type     = D
numb_ops    = 1.0000, 0.0000, 0.0000
frst_a_nois = 22
```

```
  numb_a_nois = 6
  frst_p_nois = 28
  numb_p_nois = 6
  model_type  = I
  spect_nums  = 204, 103, 0
  flt_path    = D-19-19D0-3-STANDARD-1
  numb_segs   = 22
  seg  start-x   start-y  start-z   unit-x  unit-y  unit-z   length   speed  d.spd   thrust    d.thr  op
   0     -42.6   -1524.9      0.0   0.0279  0.9996  0.0000    574.0    35.0   20.8  50997.7  -1319.2   D
   1     -26.6    -951.1      0.0   0.0279  0.9996  0.0000    574.0    55.8   20.8  49678.4  -1319.2   D
   2     -10.5    -377.4      0.0   0.0279  0.9996  0.0000    574.0    76.5   20.8  48359.2  -1319.2   D
   3       5.5     196.4      0.0   0.0279  0.9996  0.0000    574.0    97.3   20.8  47040.0  -1319.2   D
   4      21.5     770.2      0.0   0.0279  0.9996  0.0000    574.0   118.1   20.8  45720.8  -1319.2   D
   5      37.5    1344.0      0.0   0.0279  0.9996  0.0000    574.0   138.9   20.8  44401.5  -1319.2   D
   6      53.6    1917.8      0.0   0.0268  0.9582  0.2849    351.0   159.6    0.2  43082.3    124.2   D
   7      63.0    2254.1    100.0   0.0268  0.9582  0.2849   1053.0   159.9    0.7  43206.5    372.5   D
   8      91.1    3263.1    400.0   0.0268  0.9582  0.2849   2106.0   160.6    1.4  43579.0    745.0   D
   9     147.5    5281.0   1000.0   0.0278  0.9957  0.0889   2061.2   162.0   26.4  44323.9  -1042.0   D
  10     204.8    7333.2   1183.2   0.0272  0.9754  0.2188   1024.8   188.5    0.6  43281.9  -8552.7   D
  11     232.7    8332.8   1407.4   0.0272  0.9754  0.2188   7280.2   189.1    4.6  34729.2   1817.6   D
  12     431.1   15433.9   3000.0   0.0279  0.9975  0.0656   3692.0   193.7   26.4  36546.9   -638.7   D
  13     533.9   19116.5   3242.3   0.0279  0.9975  0.0656   3692.0   220.1   26.4  35908.2   -638.7   D
  14     636.8   22799.1   3484.6   0.0279  0.9975  0.0656   3692.0   246.4   26.4  35269.5   -638.7   D
  15     739.7   26481.8   3726.9   0.0275  0.9831  0.1809   8580.6   272.8    6.6  34630.8   1553.3   D
  16     975.3   34917.6   5278.8  -0.1357  0.9741  0.1809   1223.1   279.4    0.9  36184.0    221.4   D
  17     809.3   36109.0   5500.0  -0.1358  0.9749  0.1764   8474.3   280.3    6.6  36405.4   1495.4   D
  18    -341.8   44370.6   6994.8  -0.5485  0.8173  0.1764   2864.4   286.9    2.2  37900.9    505.5   D
  19   -1913.1   46711.6   7500.0  -0.5492  0.8182  0.1701   6824.4   289.2    5.4  38406.3   1161.6   D
  20   -5660.7   52295.5   8661.1  -0.7863  0.5940  0.1701   7869.3   294.6    6.2  39568.0   1339.5   D
  21  -11848.3   56969.6  10000.0  -0.7863  0.5940  0.1701      1.0   300.8    0.0  40907.5      0.0   D
7
  acft_id     = A32023
  eng_type    = J
  owner_cat   = C
  op_type     = A
  numb_ops    = 1.0000, 0.0000, 0.0000
```

```
frst_a_nois = 34
numb_a_nois = 7
frst_p_nois = 41
numb_p_nois = 7
model_type  = I
spect_nums  = 205, 103, 0
flt_path    = A-01-01A0-3-STANDARD-1
numb_segs   = 37
```

seg	start-x	start-y	start-z	unit-x	unit-y	unit-z	length	speed	d.spd	thrust	d.thr	op
0	-89842.6	-32.5	6000.0	0.9286	-0.3677	-0.0500	4749.2	272.3	-0.9	150.1	-6.1	A
1	-85432.5	-1778.6	5762.4	0.9767	-0.2088	-0.0500	11945.4	271.4	-2.3	143.9	-15.4	A
2	-73765.7	-4272.9	5164.9	0.9696	0.2394	-0.0500	9813.8	269.1	-1.9	128.5	-12.7	A
3	-64249.9	-1923.6	4674.0	0.9696	0.2394	-0.0504	2131.7	267.2	-0.4	115.8	-2.3	A
4	-62183.0	-1413.3	4566.5	0.8382	0.5430	-0.0504	11362.0	266.8	-2.2	113.5	-12.3	A
5	-52658.9	4755.7	3993.4	0.8382	0.5429	-0.0507	583.6	264.6	-0.1	101.2	-0.9	A
6	-52169.6	5072.6	3963.8	0.5163	0.8549	-0.0507	11917.6	264.5	-2.3	100.3	-18.4	A
7	-46016.0	15260.7	3359.3	0.5164	0.8549	-0.0510	28.2	262.2	-0.0	81.9	-0.1	A
8	-46001.5	15284.8	3357.9	0.4843	0.8734	-0.0510	6819.3	262.2	-1.3	81.8	-14.7	A
9	-42699.0	21241.0	3010.4	0.4843	0.8734	-0.0510	204.0	260.9	0.0	67.1	1.0	A
10	-42600.2	21419.1	3000.0	0.4849	0.8746	0.0000	4120.9	260.9	-11.0	68.1	-13.8	A
11	-40602.0	25023.1	3000.0	0.7569	0.6535	0.0000	5567.5	249.9	-14.9	54.2	-18.7	A
12	-36387.8	28661.5	3000.0	0.7569	0.6535	0.0000	5567.5	235.0	-14.9	35.6	-18.7	A
13	-32173.7	32300.0	3000.0	0.8988	0.4383	0.0000	4748.4	220.2	-12.7	16.9	-15.9	A
14	-27905.5	34381.1	3000.0	0.8988	0.4383	0.0000	3594.9	207.5	-12.0	1.0	0.0	A
15	-24674.3	35956.6	3000.0	0.8982	0.4379	-0.0392	2793.9	195.5	-5.0	1.0	0.0	A
16	-22164.9	37180.1	2890.6	0.9941	0.1011	-0.0392	1311.5	190.5	-2.4	1.0	0.0	A
17	-20861.2	37312.7	2839.2	0.9935	0.1010	-0.0524	303.4	188.1	-0.7	1.0	361.5	A
18	-20559.7	37343.3	2823.3	0.9935	0.1010	-0.0523	3983.5	187.4	-9.0	362.5	35.4	A
19	-16602.2	37745.8	2614.8	0.9935	0.1010	-0.0523	5551.2	178.4	-16.5	397.8	133.4	A
20	-11087.0	38306.7	2324.3	0.9798	-0.1928	-0.0523	4778.7	161.9	-14.2	531.2	114.8	A
21	-6404.6	37385.4	2074.2	0.7968	-0.6019	-0.0523	393.8	147.8	-1.2	646.0	9.5	A
22	-6090.9	37148.3	2053.6	0.7968	-0.6019	-0.0524	2157.8	146.6	-8.8	655.5	88.4	A
23	-4371.5	35849.5	1940.6	0.7967	-0.6019	-0.0535	31.7	137.8	-0.1	743.8	1.5	A
24	-4346.2	35830.4	1938.9	0.7968	-0.6019	-0.0521	218.8	137.7	-0.1	745.3	4174.0	A
25	-4171.9	35698.7	1927.5	0.7968	-0.6019	-0.0523	1976.6	137.6	-0.2	4919.3	-18.3	A
26	-2596.8	34508.9	1824.1	0.5565	-0.8292	-0.0523	4778.7	137.4	-0.5	4901.0	-44.2	A

27	62.6	30546.4	1574.0	0.1378	-0.9891	-0.0523	4778.7	136.9	-0.5	4856.8	-44.2	A
28	721.2	25819.9	1323.9	-0.0279	-0.9982	-0.0523	1308.3	136.4	-0.1	4812.6	-12.1	A
29	684.7	24513.9	1255.4	-0.0279	-0.9982	-0.0523	12924.3	136.3	-1.3	4800.5	-115.3	A
30	324.3	11612.3	578.9	-0.0279	-0.9982	-0.0523	9180.2	135.0	-1.0	4685.2	-82.8	A
31	68.4	2448.3	98.4	-0.0279	-0.9982	-0.0523	925.2	134.0	-0.1	4602.4	-32.0	A
32	42.6	1524.7	50.0	-0.0279	-0.9982	-0.0523	955.3	133.9	0.0	4570.5	0.0	A
33	16.0	571.1	0.0	-0.0279	-0.9996	0.0000	347.4	133.9	-7.0	4570.5	11329.5	A
34	6.3	223.9	0.0	-0.0279	-0.9996	0.0000	1563.3	126.9	-48.5	15900.0	-6625.0	D
35	-37.4	-1338.8	0.0	-0.0279	-0.9996	0.0000	1563.3	78.4	-48.4	9275.0	-6625.0	D
36	-81.0	-2901.5	0.0	-0.0279	-0.9996	0.0000	1.0	30.0	0.0	2650.0	0.0	A

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```
acft_id     = A32023
eng_type    = J
owner_cat   = C
op_type     = A
numb_ops    = 3.0000, 0.0000, 0.0000
frst_a_nois = 34
numb_a_nois = 7
frst_p_nois = 41
numb_p_nois = 7
model_type  = I
spect_nums  = 205, 103, 0
flt_path    = A-19-19A0-3-STANDARD-1
numb_segs   = 33
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seg	start-x	start-y	start-z	unit-x	unit-y	unit-z	length	speed	d.spd	thrust	d.thr	op
0	-98297.2	-72213.6	6000.0	0.9716	0.2315	-0.0500	13254.1	272.3	-2.5	150.1	-17.1	A
1	-85420.0	-69145.8	5337.0	0.9716	0.2315	-0.0500	13254.1	269.8	-2.5	132.9	-17.1	A
2	-72542.9	-66078.1	4674.0	0.9715	0.2315	-0.0504	13493.7	267.2	-2.6	115.8	-14.6	A
3	-59433.3	-62954.9	3993.4	0.9715	0.2315	-0.0507	6001.4	264.6	-1.2	101.2	-9.3	A
4	-53602.7	-61565.8	3689.0	0.9715	0.2315	-0.0507	6499.8	263.4	-1.2	91.9	-10.1	A
5	-47288.0	-60061.4	3359.3	0.9715	0.2314	-0.0510	6847.5	262.2	-1.3	81.9	-14.8	A
6	-40635.5	-58476.6	3010.4	0.9715	0.2314	-0.0510	204.0	260.9	0.0	67.1	1.0	A
7	-40437.4	-58429.4	3000.0	0.9728	0.2317	0.0000	5615.6	260.9	-15.0	68.1	-18.8	A
8	-34974.7	-57128.0	3000.0	0.9728	0.2317	0.0000	5615.6	245.9	-15.0	49.2	-18.8	A
9	-29511.9	-55826.6	3000.0	0.9728	0.2317	0.0000	5615.6	230.9	-15.0	30.4	-18.8	A
10	-24049.2	-54525.2	3000.0	0.9210	0.3896	0.0000	3157.6	215.9	-8.4	11.6	-10.6	A

11	-21141.2	-53294.8	3000.0	0.9210	0.3896	0.0000	3594.9	207.5	-12.0	1.0	0.0	A
12	-17830.4	-51894.1	3000.0	0.9203	0.3893	-0.0392	4105.4	195.5	-7.4	1.0	0.0	A
13	-14052.4	-50295.7	2839.2	0.9197	0.3891	-0.0524	303.4	188.1	-0.7	1.0	361.5	A
14	-13773.3	-50177.7	2823.3	0.9197	0.3891	-0.0523	773.8	187.4	-1.7	362.5	6.9	A
15	-13061.7	-49876.6	2782.8	0.6569	0.7522	-0.0523	3209.7	185.7	-7.3	369.3	28.5	A
16	-10953.3	-47462.4	2614.8	0.6569	0.7522	-0.0523	4368.6	178.4	-13.0	397.8	105.0	A
17	-8083.6	-44176.5	2386.2	0.6569	0.7522	-0.0523	4368.6	165.4	-13.0	502.8	105.0	A
18	-5213.9	-40890.6	2157.6	0.4260	0.9032	-0.0523	1986.6	152.5	-5.9	607.7	47.7	A
19	-4367.6	-39096.4	2053.6	0.4260	0.9032	-0.0524	2157.8	146.6	-8.8	655.5	88.4	A
20	-3448.3	-37147.5	1940.6	0.4260	0.9031	-0.0535	31.7	137.8	-0.1	743.8	1.5	A
21	-3434.8	-37118.8	1938.9	0.4260	0.9032	-0.0521	218.8	137.7	-0.1	745.3	4174.0	A
22	-3341.5	-36921.2	1927.5	0.4260	0.9032	-0.0523	3569.6	137.6	-0.4	4919.3	-33.0	A
23	-1820.7	-33697.2	1740.7	0.1381	0.9890	-0.0523	7964.5	137.2	-0.8	4886.3	-73.7	A
24	-721.2	-25819.9	1323.9	0.0279	0.9982	-0.0523	1308.2	136.4	-0.1	4812.6	-12.1	A
25	-684.7	-24514.0	1255.4	0.0279	0.9982	-0.0523	12924.3	136.3	-1.3	4800.5	-115.3	A
26	-324.3	-11612.4	578.9	0.0279	0.9982	-0.0523	9180.2	135.0	-1.0	4685.2	-82.8	A
27	-68.4	-2448.4	98.4	0.0279	0.9982	-0.0523	925.2	134.0	-0.1	4602.4	-32.0	A
28	-42.6	-1524.9	50.0	0.0279	0.9982	-0.0523	955.3	133.9	0.0	4570.5	0.0	A
29	-16.0	-571.2	0.0	0.0279	0.9996	0.0000	347.4	133.9	-7.0	4570.5	11329.5	A
30	-6.3	-224.0	0.0	0.0279	0.9996	0.0000	1563.3	126.9	-48.5	15900.0	-6625.0	D
31	37.4	1338.7	0.0	0.0279	0.9996	0.0000	1563.3	78.4	-48.4	9275.0	-6625.0	D
32	81.0	2901.4	0.0	0.0279	0.9996	0.0000	1.0	30.0	0.0	2650.0	0.0	A

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acft_id     = A32023
eng_type    = J
owner_cat   = C
op_type     = D
numb_ops    = 1.0000, 0.0000, 0.0000
frst_a_nois = 34
numb_a_nois = 7
frst_p_nois = 41
numb_p_nois = 7
model_type  = I
spect_nums  = 205, 103, 0
flt_path    = D-01-01D0-3-STANDARD-1
numb_segs   = 28
```

seg	start-x	start-y	start-z	unit-x	unit-y	unit-z	length	speed	d.spd	thrust	d.thr	op
0	42.6	1524.9	0.0	-0.0279	-0.9996	0.0000	572.7	35.0	19.0	24860.3	-607.0	D
1	26.6	952.4	0.0	-0.0279	-0.9996	0.0000	572.7	54.0	19.0	24253.4	-607.0	D
2	10.6	379.9	0.0	-0.0279	-0.9996	0.0000	572.7	72.9	19.0	23646.4	-607.0	D
3	-5.4	-192.5	0.0	-0.0279	-0.9996	0.0000	572.7	91.9	19.0	23039.4	-607.0	D
4	-21.4	-765.0	0.0	-0.0279	-0.9996	0.0000	572.7	110.9	19.0	22432.5	-607.0	D
5	-37.4	-1337.5	0.0	-0.0279	-0.9996	0.0000	572.7	129.8	19.0	21825.5	-607.0	D
6	-53.3	-1910.0	0.0	-0.0271	-0.9693	0.2443	409.3	148.8	0.2	21218.5	32.0	D
7	-64.4	-2306.8	100.0	-0.0271	-0.9693	0.2443	1228.0	149.0	0.7	21250.6	96.1	D
8	-97.7	-3497.1	400.0	-0.0271	-0.9693	0.2443	2455.9	149.7	1.3	21346.6	192.2	D
9	-164.2	-5877.6	1000.0	-0.0278	-0.9969	0.0731	2001.9	151.0	22.0	21538.8	-472.4	D
10	-219.9	-7873.3	1146.3	-0.0278	-0.9969	0.0731	2001.9	173.1	22.0	21066.4	-472.4	D
11	-275.7	-9869.1	1292.6	-0.0279	-0.9973	0.0686	2797.2	195.1	24.9	20594.1	-518.3	D
12	-353.6	-12658.6	1484.4	-0.0277	-0.9905	0.1350	1009.2	220.0	0.5	20075.8	-5915.3	D
13	-381.5	-13658.2	1620.7	-0.0277	-0.9905	0.1350	3067.4	220.5	1.4	14160.6	74.1	D
14	-466.3	-16696.3	2034.8	-0.1913	-0.9722	0.1350	7148.1	221.9	3.2	14234.7	172.7	D
15	-1833.8	-23645.7	3000.0	-0.1928	-0.9800	0.0498	2464.8	225.1	10.9	14407.4	122.9	D
16	-2309.0	-26061.1	3122.8	-0.6020	-0.7969	0.0498	4060.9	236.0	18.0	14530.3	202.5	D
17	-4753.7	-29297.3	3325.0	-0.6020	-0.7969	0.0498	4060.9	254.0	18.0	14732.7	202.5	D
18	-7198.4	-32533.5	3527.3	-0.5977	-0.7912	0.1297	1444.9	271.9	0.8	14935.2	30.5	D
19	-8062.0	-33676.7	3714.7	-0.8233	-0.5526	0.1297	9625.7	272.7	5.3	14965.7	203.4	D
20	-15986.9	-38995.6	4963.3	-0.9821	-0.1368	0.1297	4137.5	278.0	2.3	15169.2	87.4	D
21	-20050.2	-39561.8	5500.0	-0.9832	-0.1370	0.1203	5481.6	280.3	2.9	15256.6	107.4	D
22	-25439.9	-40312.7	6159.4	-0.9924	0.0277	0.1203	11143.2	283.2	5.9	15364.0	218.3	D
23	-36497.9	-40003.9	7500.0	-0.9936	0.0278	0.1099	9718.1	289.2	5.0	15582.3	174.0	D
24	-46153.3	-39734.2	8568.4	-0.9936	0.0278	0.1099	9718.1	294.1	5.0	15756.3	174.0	D
25	-55808.6	-39464.5	9636.7	-0.9919	0.0644	0.1099	2667.4	299.1	1.4	15930.3	47.8	D
26	-58454.3	-39292.8	9930.0	-0.9803	0.1638	0.1099	637.1	300.5	0.3	15978.0	11.4	D
27	-59078.9	-39188.4	10000.0	-0.9803	0.1638	0.1099	1.0	300.8	0.0	15989.4	0.0	D

10

```
acft_id     = A32023
eng_type    = J
owner_cat   = C
op_type     = D
numb_ops    = 3.0000, 0.0000, 0.0000
frst_a_nois = 34
```

```
numb_a_nois = 7
frst_p_nois = 41
numb_p_nois = 7
model_type  = I
spect_nums  = 205, 103, 0
flt_path    = D-19-19D0-3-STANDARD-1
numb_segs   = 27
```

seg	start-x	start-y	start-z	unit-x	unit-y	unit-z	length	speed	d.spd	thrust	d.thr	op
0	-42.6	-1524.9	0.0	0.0279	0.9996	0.0000	541.9	35.0	19.0	24860.3	-607.0	D
1	-27.5	-983.2	0.0	0.0279	0.9996	0.0000	541.9	54.0	19.0	24253.4	-607.0	D
2	-12.3	-441.5	0.0	0.0279	0.9996	0.0000	541.9	72.9	19.0	23646.4	-607.0	D
3	2.8	100.3	0.0	0.0279	0.9996	0.0000	541.9	91.9	19.0	23039.4	-607.0	D
4	17.9	642.0	0.0	0.0279	0.9996	0.0000	541.9	110.9	19.0	22432.5	-607.0	D
5	33.1	1183.8	0.0	0.0279	0.9996	0.0000	541.9	129.8	19.0	21825.5	-607.0	D
6	48.2	1725.5	0.0	0.0270	0.9679	0.2500	400.0	148.8	0.2	21218.5	32.0	D
7	59.0	2112.7	100.0	0.0270	0.9679	0.2500	1200.1	149.0	0.7	21250.6	96.1	D
8	91.5	3274.2	400.0	0.0270	0.9679	0.2500	2400.1	149.7	1.3	21346.6	192.2	D
9	156.3	5597.2	1000.0	0.0278	0.9968	0.0745	1963.7	151.0	22.0	21538.8	-472.4	D
10	211.0	7554.7	1146.3	0.0278	0.9968	0.0745	1963.7	173.1	22.0	21066.4	-472.4	D
11	265.7	9512.2	1292.6	0.0279	0.9972	0.0697	2753.1	195.1	24.9	20594.1	-518.3	D
12	342.4	12257.5	1484.4	0.0277	0.9902	0.1372	1009.5	220.0	0.5	20075.8	-5915.3	D
13	370.3	13257.1	1622.9	0.0277	0.9902	0.1372	10039.4	220.5	4.6	14160.6	246.8	D
14	647.9	23197.8	3000.0	0.0279	0.9983	0.0505	3482.6	225.1	15.6	14407.4	175.9	D
15	745.0	26674.6	3175.8	0.0279	0.9983	0.0505	3482.6	240.7	15.6	14583.3	175.9	D
16	842.2	30151.3	3351.5	0.0279	0.9983	0.0505	3482.6	256.3	15.6	14759.3	175.9	D
17	939.3	33628.1	3527.3	0.0277	0.9909	0.1314	1301.2	271.9	0.7	14935.2	27.9	D
18	975.3	34917.6	3698.3	-0.1368	0.9818	0.1314	9627.8	272.7	5.4	14963.1	206.1	D
19	-341.8	44370.6	4963.6	-0.5524	0.8231	0.1314	4081.6	278.0	2.3	15169.2	87.4	D
20	-2596.7	47730.2	5500.0	-0.5531	0.8241	0.1219	5539.5	280.3	3.0	15256.6	110.0	D
21	-5660.7	52295.5	6175.2	-0.7920	0.5983	0.1219	9616.0	283.3	5.2	15366.6	190.9	D
22	-13276.4	58048.4	7347.3	-0.9739	0.1916	0.1219	1253.2	288.5	0.7	15557.4	24.9	D
23	-14496.8	58288.6	7500.0	-0.9751	0.1919	0.1114	8352.5	289.2	4.3	15582.3	151.5	D
24	-22641.1	59891.1	8430.3	-0.9934	0.0277	0.1114	7046.2	293.5	3.7	15733.8	127.8	D
25	-29640.7	60086.6	9215.2	-0.9934	0.0277	0.1114	7046.2	297.1	3.7	15861.6	127.8	D
26	-36640.3	60282.1	10000.0	-0.9934	0.0277	0.1114	1.0	300.8	0.0	15989.4	0.0	D

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```
acft_id     = A340
eng_type    = J
owner_cat   = C
op_type     = A
numb_ops    = 3.0000
frst_a_nois = 48
numb_a_nois = 5
frst_p_nois = 53
numb_p_nois = 5
model_type  = I
spect_nums  = 206, 107, 0
flt_path    = A-19-19A0-3-STANDARD-1
numb_segs   = 39
```

seg	start-x	start-y	start-z	unit-x	unit-y	unit-z	length	speed	d.spd	thrust	d.thr	op
0	-128457.9	-79399.0	6000.0	0.9720	0.2316	-0.0408	446.2	272.3	0.0	932.8	-2.0	A
1	-128024.2	-79295.7	5981.8	0.9720	0.2316	-0.0405	13056.7	272.3	-2.0	930.8	14.5	A
2	-115333.5	-76272.3	5452.8	0.9720	0.2316	-0.0405	13056.7	270.3	-2.0	945.3	14.5	A
3	-102642.7	-73248.9	4923.8	0.9720	0.2316	-0.0400	23115.2	268.2	-3.6	959.8	42.2	A
4	-80174.8	-67896.2	3998.8	0.9720	0.2316	-0.0397	3029.5	264.6	-0.4	1002.0	4.7	A
5	-77230.1	-67194.7	3878.5	0.9720	0.2316	-0.0395	17637.6	264.2	-2.6	1006.7	23.7	A
6	-60086.0	-63110.4	3182.2	0.9720	0.2316	-0.0393	4637.9	261.6	-0.7	1030.4	-5.7	A
7	-55577.9	-62036.4	3000.0	0.9728	0.2317	0.0000	2030.4	260.9	-3.8	1024.7	15.1	A
8	-53602.7	-61565.8	3000.0	0.9728	0.2317	0.0000	6252.9	257.1	-11.7	1039.8	46.5	A
9	-47520.1	-60116.8	3000.0	0.9728	0.2317	0.0000	6252.9	245.4	-11.7	1086.3	46.5	A
10	-41437.5	-58667.7	3000.0	0.9728	0.2317	0.0000	6252.9	233.7	-11.7	1132.9	46.5	A
11	-35354.8	-57218.6	3000.0	0.9728	0.2317	0.0000	4099.5	222.0	-9.8	1179.4	21.8	A
12	-31366.9	-56268.5	3000.0	0.9728	0.2317	0.0000	5308.9	212.2	-15.1	1201.2	15.3	A
13	-26202.6	-55038.2	3000.0	0.9728	0.2317	0.0000	2213.6	197.1	-6.8	1216.5	-8.8	A
14	-24049.2	-54525.2	3000.0	0.9210	0.3896	0.0000	2308.6	190.3	-7.0	1207.7	-9.2	A
15	-21923.1	-53625.6	3000.0	0.9210	0.3896	0.0000	4765.4	183.3	-19.3	1198.5	-25.8	A
16	-17534.3	-51768.9	3000.0	0.9210	0.3896	0.0000	157.7	164.0	-0.7	1172.6	2.0	A
17	-17389.1	-51707.4	3000.0	0.9210	0.3896	0.0000	554.3	163.3	-2.7	1174.7	17.5	A
18	-16878.6	-51491.4	3000.0	0.9197	0.3891	-0.0525	308.8	160.6	-0.4	1192.1	1.6	A
19	-16594.5	-51371.3	2983.8	0.9197	0.3891	-0.0523	3841.3	160.2	-9.0	1193.7	42.6	A
20	-13061.7	-49876.6	2782.8	0.6569	0.7522	-0.0523	648.7	151.2	-1.5	1236.3	7.2	A
21	-12635.6	-49388.7	2748.8	0.6569	0.7522	-0.0523	1811.3	149.7	-5.8	1243.5	26.0	A

22	-11445.8	-48026.3	2654.0	0.6569	0.7522	-0.0523	365.3	143.9	-1.3	1269.5	5.5	A
23	-11205.8	-47751.6	2634.9	0.6569	0.7522	-0.0523	1370.9	142.6	-5.4	1275.0	22.7	A
24	-10305.3	-46720.4	2563.2	0.6569	0.7522	-0.0523	218.0	137.2	-0.1	1297.7	4412.1	A
25	-10162.1	-46556.5	2551.8	0.6569	0.7522	-0.0523	7532.7	137.1	-0.8	5709.8	-79.9	A
26	-5213.9	-40890.6	2157.5	0.4260	0.9032	-0.0523	5261.7	136.3	-0.5	5629.9	-55.8	A
27	-2972.3	-36138.4	1882.1	0.4260	0.9032	-0.0523	2702.9	135.8	-0.3	5574.1	-27.7	A
28	-1820.7	-33697.2	1740.6	0.1381	0.9890	-0.0523	7964.5	135.5	-0.8	5546.4	-81.8	A
29	-721.2	-25819.9	1323.8	0.0279	0.9982	-0.0523	2208.7	134.7	-0.2	5464.6	-22.7	A
30	-659.6	-23615.1	1208.2	0.0279	0.9982	-0.0523	3978.1	134.5	-0.4	5441.9	-41.3	A
31	-548.7	-19644.0	1000.0	0.0279	0.9982	-0.0523	12702.3	134.1	-1.3	5400.6	-126.5	A
32	-194.5	-6964.0	335.2	0.0279	0.9982	-0.0523	4415.3	132.8	-0.5	5274.1	-194.0	A
33	-71.4	-2556.6	104.1	0.0279	0.9982	-0.0523	1033.5	132.3	-0.1	5080.1	-499.6	A
34	-42.6	-1524.9	50.0	0.0279	0.9982	-0.0523	955.3	132.2	0.0	4580.4	0.0	A
35	-16.0	-571.2	0.0	0.0279	0.9996	0.0000	440.3	132.2	-7.0	4580.4	14139.6	A
36	-3.7	-131.1	0.0	0.0279	0.9996	0.0000	1981.2	125.2	-47.6	18720.0	-7800.0	D
37	51.7	1849.4	0.0	0.0279	0.9996	0.0000	1981.2	77.6	-47.6	10920.0	-7800.0	D
38	107.0	3829.8	0.0	0.0279	0.9996	0.0000	1.0	30.0	0.0	3120.0	0.0	A

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```
acft_id     = A340
eng_type    = J
owner_cat   = C
op_type     = D
numb_ops    = 3.0000
frst_a_nois = 48
numb_a_nois = 5
frst_p_nois = 53
numb_p_nois = 5
model_type  = I
spect_nums  = 206, 107, 0
flt_path    = D-19-19D0-3-STANDARD-1
numb_segs   = 27
```

seg	start-x	start-y	start-z	unit-x	unit-y	unit-z	length	speed	d.spd	thrust	d.thr	op
0	-42.6	-1524.9	0.0	0.0279	0.9996	0.0000	596.4	35.0	17.5	29441.6	-681.8	D
1	-25.9	-928.7	0.0	0.0279	0.9996	0.0000	596.4	52.5	17.5	28759.8	-681.8	D
2	-9.3	-332.5	0.0	0.0279	0.9996	0.0000	596.4	70.1	17.5	28078.0	-681.8	D
3	7.4	263.7	0.0	0.0279	0.9996	0.0000	596.4	87.6	17.5	27396.1	-681.8	D

4	24.0	859.9	0.0	0.0279	0.9996	0.0000	596.4	105.2	17.5	26714.3	-681.8	D
5	40.7	1456.1	0.0	0.0279	0.9996	0.0000	596.4	122.7	17.5	26032.5	-681.8	D
6	57.3	2052.3	0.0	0.0273	0.9791	0.2015	496.3	140.2	0.2	25350.6	34.7	D
7	70.9	2538.2	100.0	0.0273	0.9791	0.2015	1488.8	140.5	0.6	25385.3	104.0	D
8	111.6	3995.9	400.0	0.0273	0.9791	0.2015	2977.6	141.1	1.3	25489.3	208.0	D
9	193.0	6911.2	1000.0	0.0279	0.9975	0.0656	2460.4	142.3	22.3	25697.3	-570.9	D
10	261.6	9365.4	1161.3	0.0279	0.9975	0.0656	2460.4	164.6	22.3	25126.4	-570.9	D
11	330.1	11819.6	1322.6	0.0279	0.9980	0.0561	2854.7	186.9	20.3	24555.5	-510.3	D
12	409.7	14668.7	1482.7	0.0279	0.9980	0.0561	2854.7	207.2	20.3	24045.2	-510.3	D
13	489.3	17517.8	1642.7	0.0276	0.9889	0.1457	1010.8	227.5	0.5	23534.9	-3401.4	D
14	517.2	18517.4	1790.0	0.0276	0.9889	0.1457	8304.2	228.0	4.2	20133.5	430.2	D
15	746.6	26729.7	3000.0	0.0279	0.9984	0.0487	4100.4	232.2	18.9	20563.8	-463.0	D
16	860.9	30823.6	3199.6	0.0279	0.9984	0.0487	4100.4	251.1	18.9	20100.7	-463.0	D
17	975.3	34917.6	3399.3	-0.1378	0.9893	0.0487	326.8	270.0	1.5	19637.7	-36.9	D
18	930.2	35240.8	3415.2	-0.1369	0.9824	0.1271	9293.3	271.5	5.0	19600.8	374.5	D
19	-341.8	44370.6	4596.4	-0.5528	0.8236	0.1271	7108.8	276.5	3.8	19975.3	286.5	D
20	-4271.3	50225.3	5500.0	-0.5533	0.8244	0.1195	2511.2	280.3	1.3	20261.8	95.1	D
21	-5660.7	52295.5	5800.0	-0.7922	0.5984	0.1195	9613.2	281.6	5.1	20356.9	364.0	D
22	-13276.4	58048.4	6948.4	-0.9742	0.1917	0.1195	4616.9	286.7	2.4	20720.9	174.8	D
23	-17774.0	58933.4	7500.0	-0.9751	0.1919	0.1110	4991.3	289.2	2.6	20895.7	175.7	D
24	-22641.1	59891.1	8054.3	-0.9934	0.0277	0.1110	8761.1	291.7	4.5	21071.4	308.4	D
25	-31344.6	60134.2	9027.1	-0.9934	0.0277	0.1110	8761.1	296.3	4.5	21379.8	308.4	D
26	-40048.1	60377.3	10000.0	-0.9934	0.0277	0.1110	1.0	300.8	0.0	21688.2	0.0	D

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```
acft_id      = LEAR25
eng_type     = J
owner_cat    = G
op_type      = A
numb_ops     = 2.0000
frst_a_nois  = 58
numb_a_nois  = 4
frst_p_nois  = 62
numb_p_nois  = 4
model_type   = I
spect_nums   = 202, 113, 0
flt_path     = A-19-19A0-3-STANDARD-1
```

numb_segs = 21

seg	start-x	start-y	start-z	unit-x	unit-y	unit-z	length	speed	d.spd	thrust	d.thr	op
0	-72162.9	-65987.5	6000.0	0.9714	0.2314	-0.0523	6368.6	282.5	-12.0	153.4	18.9	A
1	-65976.2	-64513.6	5666.7	0.9714	0.2314	-0.0523	6368.6	270.5	-12.0	172.4	18.9	A
2	-59789.4	-63039.7	5333.4	0.9714	0.2314	-0.0523	6368.6	258.5	-12.0	191.3	18.9	A
3	-53602.7	-61565.8	5000.1	0.9714	0.2314	-0.0523	6084.5	246.4	-11.5	210.2	18.1	A
4	-47692.0	-60157.7	4681.6	0.9714	0.2314	-0.0523	6084.5	235.0	-11.5	228.3	18.1	A
5	-41781.3	-58749.6	4363.2	0.9714	0.2314	-0.0523	6084.5	223.5	-11.5	246.4	18.1	A
6	-35870.6	-57341.4	4044.8	0.9714	0.2314	-0.0523	6084.5	212.0	-11.5	264.5	18.1	A
7	-29959.9	-55933.3	3726.3	0.9714	0.2314	-0.0523	6084.5	200.6	-11.5	282.6	18.1	A
8	-24049.2	-54525.2	3407.9	0.9197	0.3891	-0.0523	3896.9	189.1	-7.3	300.6	11.6	A
9	-20465.2	-53008.8	3203.9	0.9197	0.3891	-0.0523	3896.9	181.7	-7.3	312.2	11.6	A
10	-16881.2	-51492.5	3000.0	0.9197	0.3891	-0.0523	4152.9	174.4	-2.1	323.8	48.0	A
11	-13061.7	-49876.6	2782.7	0.6569	0.7522	-0.0523	11946.8	172.3	-6.0	371.8	138.1	A
12	-5213.9	-40890.6	2157.4	0.4260	0.9032	-0.0523	7964.5	166.3	-4.0	509.8	92.0	A
13	-1820.7	-33697.2	1740.6	0.1381	0.9890	-0.0523	4596.7	162.3	-2.3	601.9	53.1	A
14	-1186.1	-29150.8	1500.0	0.1381	0.9890	-0.0523	3367.8	159.9	-4.1	655.0	56.2	A
15	-721.2	-25819.9	1323.7	0.0279	0.9982	-0.0523	6185.9	155.9	-7.5	711.2	103.3	A
16	-548.7	-19644.9	1000.0	0.0279	0.9982	-0.0523	19107.4	148.4	-2.3	814.5	-29.1	A
17	-16.0	-571.2	0.0	0.0279	0.9996	0.0000	140.4	146.1	-7.5	785.4	984.6	A
18	-12.0	-430.9	0.0	0.0279	0.9996	0.0000	631.8	138.7	-53.9	1770.0	-737.5	D
19	5.6	200.7	0.0	0.0279	0.9996	0.0000	631.8	84.8	-53.9	1032.5	-737.5	D
20	23.2	832.3	0.0	0.0279	0.9996	0.0000	1.0	30.9	0.0	295.0	0.0	A

14

acft_id = LEAR25
eng_type = J
owner_cat = G
op_type = D
numb_ops = 2.0000
frst_a_nois = 58
numb_a_nois = 4
frst_p_nois = 62
numb_p_nois = 4
model_type = I
spect_nums = 202, 113, 0
flt_path = D-19-19D0-3-STANDARD-1

numb_segs = 27

seg	start-x	start-y	start-z	unit-x	unit-y	unit-z	length	speed	d.spd	thrust	d.thr	op
0	-42.6	-1524.9	0.0	0.0279	0.9996	0.0000	633.7	35.0	21.0	2839.5	-53.0	D
1	-24.9	-891.4	0.0	0.0279	0.9996	0.0000	633.7	56.0	21.0	2786.5	-53.0	D
2	-7.2	-258.0	0.0	0.0279	0.9996	0.0000	633.7	77.0	21.0	2733.4	-53.0	D
3	10.5	375.5	0.0	0.0279	0.9996	0.0000	633.7	98.0	21.0	2680.4	-53.0	D
4	28.2	1009.0	0.0	0.0279	0.9996	0.0000	633.7	119.0	21.0	2627.4	-53.0	D
5	45.9	1642.5	0.0	0.0279	0.9996	0.0000	633.7	139.9	21.0	2574.4	-53.0	D
6	63.6	2276.0	0.0	0.0278	0.9940	0.1060	213.3	160.9	1.6	2521.4	-3.4	D
7	69.5	2488.0	22.6	0.0278	0.9940	0.1060	639.9	162.5	4.8	2518.0	-10.2	D
8	87.3	3124.0	90.4	0.0278	0.9940	0.1060	1279.8	167.4	9.6	2507.8	-20.3	D
9	122.8	4396.1	226.0	0.0274	0.9797	0.1985	6416.8	177.0	3.4	2487.5	-14.5	D
10	298.4	10682.8	1500.0	0.0278	0.9954	0.0921	1846.1	180.4	13.7	2473.0	-26.8	D
11	349.7	12520.3	1670.1	0.0278	0.9954	0.0921	1846.1	194.1	13.7	2446.1	-26.8	D
12	401.0	14357.8	1840.1	0.0274	0.9800	0.1971	1020.0	207.8	0.6	2419.3	-241.9	D
13	428.9	15357.4	2041.1	0.0274	0.9800	0.1971	4865.6	208.5	3.0	2177.4	-4.8	D
14	562.1	20125.7	3000.0	0.0278	0.9956	0.0895	3571.2	211.5	15.9	2172.6	-24.6	D
15	661.4	23681.2	3319.7	0.0278	0.9956	0.0895	3571.2	227.4	15.9	2148.0	-24.6	D
16	760.8	27236.7	3639.3	0.0278	0.9956	0.0895	3571.2	243.3	15.9	2123.4	-24.6	D
17	860.1	30792.3	3959.0	0.0278	0.9956	0.0895	3571.2	259.2	15.9	2098.9	-24.6	D
18	959.4	34347.8	4278.7	0.0276	0.9880	0.1523	576.7	275.1	0.4	2074.3	0.5	D
19	975.3	34917.6	4366.5	-0.1364	0.9789	0.1523	7444.2	275.5	4.8	2074.8	6.3	D
20	-40.0	42204.6	5500.0	-0.1366	0.9806	0.1407	2208.9	280.3	1.4	2081.0	3.7	D
21	-341.8	44370.6	5810.8	-0.5517	0.8221	0.1407	9640.3	281.7	6.0	2084.7	16.0	D
22	-5660.7	52295.5	7167.4	-0.7900	0.5968	0.1407	2363.8	287.7	1.5	2100.8	3.9	D
23	-7528.1	53706.1	7500.0	-0.7915	0.5979	0.1269	7262.8	289.2	4.3	2104.7	19.0	D
24	-13276.4	58048.4	8421.6	-0.9733	0.1915	0.1269	9622.1	293.4	5.7	2123.7	25.2	D
25	-22641.1	59891.1	9642.7	-0.9915	0.0277	0.1269	2815.7	299.1	1.7	2148.9	7.4	D
26	-25433.0	59969.1	10000.0	-0.9915	0.0277	0.1269	1.0	300.8	0.0	2156.3	0.0	D

GRIDS

0

grid_id = LOCATION
grid_type = L
origin = 0.0, 0.0
angle = 0.0
delta_i,j = 0.0, 0.6

```
  numb_i,j    = 1, 1
  ta_thresh   = 85.0
  do_ambient  = 0
  delta_amb   = 0.0
  do_percent  = 0
  ref_time    = 24.00
   i   j        x          y
   0   0        0.0        0.0
1
  grid_id     = POPULATION
  grid_type   = P
  origin      = 0.0, 0.0
  angle       = 0.0
  delta_i,j   = 0.0, 0.6
  numb_i,j    = 1, 1
  ta_thresh   = 85.0
  do_ambient  = 0
  delta_amb   = 0.0
  do_percent  = 0
  ref_time    = 24.00
   i   j        x          y
   0   0        0.0        0.0
2
  grid_id     = STANDARD
  grid_type   = S
  origin      = -48608.9, -48608.9
  angle       = 0.0
  delta_i,j   = 24304.5, 24304.5
  numb_i,j    = 5, 5
  ta_thresh   = 85.0
  do_ambient  = 0
  delta_amb   = 0.0
  do_percent  = 0
  ref_time    = 24.00
   i   j        x          y
   0   0   -48608.9   -48608.9
```

```
   0   1   -48608.9   -24304.5
   0   2   -48608.9        0.0
   0   3   -48608.9    24304.5
   0   4   -48608.9    48608.9
   1   0   -24304.5   -48608.9
   1   1   -24304.5   -24304.5
   1   2   -24304.5        0.0
   1   3   -24304.5    24304.5
   1   4   -24304.5    48608.9
   2   0        0.0   -48608.9
   2   1        0.0   -24304.5
   2   2        0.0        0.0
   2   3        0.0    24304.5
   2   4        0.0    48608.9
   3   0    24304.5   -48608.9
   3   1    24304.5   -24304.5
   3   2    24304.5        0.0
   3   3    24304.5    24304.5
   3   4    24304.5    48608.9
   4   0    48608.9   -48608.9
   4   1    48608.9   -24304.5
   4   2    48608.9        0.0
   4   3    48608.9    24304.5
   4   4    48608.9    48608.9
POPULATION POINTS
   0  TOWN N             -4502.9   -11177.2
   1  TOWN S             -4301.3   -13947.2
LOCATION POINTS
  0  HOMES     -4091.8   -14421.3   423.0
  1  NACALA    -6617.2   -11906.3   297.0
  2  PORT      -7469.2   -11471.8    14.0
SCREENING POINTS
```

Introduction to Case Echo Report

The Case Echo Report documents user-generated Study Data are all Case-specific data for calculated flight operations. The purpose of this report is to provide, in one place, all of the input data for a given Case, including the Study-level data. The Study displays the perimeters established to calculate the noise contours, these perimeters include the types of aircraft the number of operations, the surroundings terrain, which at Nacala is rather flat and falling away from the airport. It also demonstrates the approach and departure profiles for landing and take offs of the aircraft.

```
INM 6.2 ECHO REPORT  20-Nov-07 10:00

STUDY: S:\8028 MOZAMBIQUE\NOISE STUDY\FAA INM\INM 62A\NACALA INTERNATIONAL\
   Created     : 21-Apr-03 12:26
   Units       : English
   Airport     : MNC
   Description :
      INTEGRATED NOISE MODEL FOR NACALA INTERNATIONAL
      AIRPORT IN NAMPULA PROVINCE, MOZAMBIQUE.
      RUNWAY 01 AND 19

CASE: NACALA 2028
   Created     : 25-Oct-07 10:41
   Description : SUMMER WIND IS FROM NE, WINTER WIND IS FROM SW

STUDY AIRPORT
   Latitude    : -14.291811 deg
   Longitude   : 40.424393 deg
   Elevation   : 371.0 ft
   Temperature : 85.0 F
   Pressure    : 29.92 in-Hg
   AverageWind : 8.0 kt
   ChangeNPD   : Yes
   Humidity    : 70.0

STUDY RUNWAYS
   01
      Latitude  : -14.282103 deg
      Longitude : 40.424671 deg
      Xcoord    : 0.0162 nmi
      Ycoord    : 0.5800 nmi
      Elevation : 407.0 ft
      OtherEnd  : 19
      Length    : 7051 ft
      Gradient  : 0.04 %
      RwyWind   : 8.0 kt
      TkoThresh : 0 ft
      AppThresh : 0 ft
   19
      Latitude  : -14.301519 deg
      Longitude : 40.424115 deg
      Xcoord    : -0.0162 nmi
      Ycoord    : -0.5800 nmi
      Elevation : 410.0 ft
      OtherEnd  : 01
      Length    : 7051 ft
      Gradient  : -0.04 %
      RwyWind   : 11.2 kt
      TkoThresh : 0 ft
      AppThresh : 0 ft
```

```
STUDY TRACKS
   RwyId-OpType-TrkId
     Sub  PctSub   TrkType   Delta(ft)
   01-APP-01A0
      3    20.00   Vectors  2000.0
   01-APP-01A1
      2    25.00   Vectors  1000.0
   01-APP-01A2
      2    25.00   Vectors  2000.0
   01-APP-01A3
      3    25.00   Vectors  2000.0
   01-DEP-01D0
      3    20.00   Vectors  2000.0
   01-DEP-01D1
      2    20.00   Vectors  2000.0
   01-DEP-01D2
      3    20.00   Vectors  2000.0
   01-DEP-01D3
      3    20.00   Vectors  2000.0
   01-DEP-01D4
      4    20.00   Vectors  2000.0
   19-APP-19A0
      3    33.00   Vectors  2000.0
   19-APP-19A1
      3   100.00   Vectors  2000.0
   19-DEP-19D0
      3    33.00   Vectors  2000.0
   19-DEP-19D1
      3    34.00   Vectors  2000.0

STUDY TRACK DETAIL
   RwyId-OpType-TrkId-SubTrk
          SegType        Dist/Angle   Radius(nmi)
   01-APP-01A0-3
       1  Left-Turn    90.0000 deg    5.0000
       2  Right-Turn   70.0000 deg    6.0000
       3  Right-Turn   90.0000 deg    2.0000
       4  Straight      4.0000 nmi
   01-APP-01A1-2
       1  Right-Turn   90.0000 deg    6.0000
       2  Left-Turn    45.0000 deg    7.0000
       3  Left-Turn    45.0000 deg    2.0000
       4  Straight      3.0000 nmi
   01-APP-01A2-2
       1  Straight     12.0000 nmi
       2  Left-Turn    60.0000 deg    5.0000
       3  Straight      4.0000 nmi
   01-APP-01A3-3
       1  Straight     10.0000 nmi
       2  Straight      4.0000 nmi
       3  Left-Turn    45.0000 deg    5.0000
   01-DEP-01D0-3
```

```
        1  Straight      3.0000 nmi
        2  Right-Turn   90.0000 deg    4.0000
        3  Straight      5.0000 nmi
        4  Right-Turn   10.0000 deg    5.0000
        5  Straight      4.0000 nmi
   01-DEP-01D1-2
        1  Straight      7.0000 nmi
        2  Left-Turn    90.0000 deg    5.0000
   01-DEP-01D2-3
        1  Straight     10.0000 nmi
        2  Right-Turn   30.0000 deg    4.0000
        3  Straight      8.0000 nmi
   01-DEP-01D3-3
        1  Straight      5.0000 nmi
        2  Left-Turn    80.0000 deg    5.0000
   01-DEP-01D4-4
        1  Straight      6.0000 nmi
        2  Right-Turn   60.0000 deg    5.0000
   19-APP-19A0-3
        1  Straight      5.0000 nmi
        2  Left-Turn    45.0000 deg    5.0000
        3  Left-Turn    30.0000 deg    5.0000
        4  Straight      4.0000 nmi
   19-APP-19A1-3
        1  Straight      4.0000 nmi
        2  Left-Turn    30.0000 deg    4.0000
        3  Straight     12.0000 nmi
   19-DEP-19D0-3
        1  Straight      6.0000 nmi
        2  Left-Turn    90.0000 deg    4.0000
        3  Straight      8.0000 nmi
   19-DEP-19D1-3
        1  Straight      9.0000 nmi
        2  Right-Turn   60.0000 deg    7.0000
        3  Straight      6.0000 nmi

STUDY AIRCRAFT
   737     Standard data
   74710Q  Standard data
   A310    Standard data
   A32023  Standard data
   A340    Standard data
   CNA20T  Standard data
   CVR580  Standard data
   GIIB    Standard data
   LEAR25  Standard data

STUDY SUBSTITUTION AIRCRAFT
   Name     Description
      Acft    Percent
   AN26     Antonov-26
      CVR580 100.0 %
```

```
CASE FLIGHT OPERATIONS
   Acft     Op   Profile Stg Rwy  Track  Sub  Group     Day     Night
   737      APP  STANDARD 1  01   01A0     3  COM    7.0000    0.0000    0.0000
   737      DEP  STANDARD 1  01   01D0     3  COM    7.0000    0.0000    0.0000
   A310     APP  STANDARD 1  01   01A0     3  COM    2.0000    0.0000    0.0000
   A310     DEP  STANDARD 1  01   01D0     3  COM    2.0000    0.0000    0.0000
   A32023   APP  STANDARD 1  01   01A0     3  COM    6.0000    0.0000    0.0000
   A32023   DEP  STANDARD 1  01   01D0     3  COM    6.0000    0.0000    0.0000
   A340     APP  STANDARD 1  01   01A0     3  COM    1.0000    0.0000    0.0000
   A340     DEP  STANDARD 1  01   01D0     3  COM    1.0000    0.0000    0.0000
   LEAR25   APP  STANDARD 1  01   01A0     3  GA     1.0000    0.0000    0.0000
   LEAR25   DEP  STANDARD 1  01   01D0     3  GA     1.0000    0.0000    0.0000

CASE RUNUP OPERATIONS
   Acft   RunupId    X(nmi)    Y(nmi)    Head    Thrust    Dur(sec)      Day
Evening     Night

CASE GRID DEFINITIONS
   Name       Type         X(nmi)    Y(nmi) Ang(deg) DisI(nmi) DisJ(nmi) NI NJ
Thrsh dAmb (hr)
   LOCATION  Location     0.0000    0.0000      0.0    0.0000    0.0001  1  1
85.0  0.0   0.00
   POPULATN  Populatn     0.0000    0.0000      0.0    0.0000    0.0001  1  1
85.0  0.0   0.00
   STANDARD  Standard    -8.0000   -8.0000      0.0    4.0000    4.0000  5  5
85.0  0.0   0.00

CASE RUN OPTIONS
   Run Type      : Single-Metric
   NoiseMetric   : DNL
   Terrain Type  : No Terrain
   Do Contour    : No
   Lateral Atten : All-Soft-Ground
   Do Population : Yes
   Do Locations  : Yes
   Do Standard   : Yes
   Do Detailed   : No
   Compute System Metrics:
      DNL    : Yes
```

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SECTION 10 CONSTRUCTION COST FOR NACALA INTERNATIONAL AIRPORT

10.1 Introduction

The present section of this report summarizes the costs of developing civilian airport facilities to handle scheduled international air services at the Nacala air base. The costs are based on the airport facility requirements as determined in Section 8 and the Conceptual Development Plans as presented in Section 9 of this report. The information is presented in the form of four tables. The first three (Tables 10.1, 10.2 and 10.3) represent the full costs of providing a first class international airport at Nacala under the assumption that there is no requirement for reimbursement of the capital expenditures from airport revenues. The fourth (Table 10.4) indicates the cost of the capital expenditures required to provide only the basic improvements that the airport revenues can support.

The following Table 10.1 summarizes the costs of the airfield, civil engineering and earthworks associated with the proposed development of Nacala airport to handle the expected traffic according to international standards.

Table 10.1 Nacala Airport Civil Works Construction Costs

	Unit	Quantity	Unit Cost (US$)	Subtotals		Total
				Imported	Local	
Airfield						
Earthworks	LS					
Crushed aggregate base	M^3	60,000	13.88	832,800	208,200	1,041,000
Bituminous surface	Ton	175,000	45	7,875,000	108,000	7,983,000
Pavement marking	LS			28,000	5,600	33,600
Airfield lighting and signage	LS			760,000	539,580	1,299,580
Drainage	LS			375,000	75,000	450,000
Navaids (incl. civil works)	LS			150,000	350,000	500,000
ILS (incl. civil works)	LS			280,000	700,000	980,000
Sub Total						**12,287,180**
Site Work						
Internal roads	LS			1,250,000	312,500	1,562,500
Security fence, gates, etc.	L.m.	15,550	50	466,500	311,000	777,500
Storm drainage	LS			75,000	18,750	93,750
Sewage treatment system	LS			187,500	46,875	234,375
Water distribution system	LS			125,000	31,250	156,250
Water storage tank	LS			180,000	49,000	229,000
Water supply line (off-site)	LS			500,000	125,000	625,000
Fuel storage & dispensing	LS			750,000	237,500	987,500
General electrical works	LS			750,000	250,000	1,000,000
Landside Improvements	LS			2,340,000	3,347,000	5,687,000
Sub Total						**11,352,875**
Grand Total of Civil (Airfield and Site) Works						**$23,640,055**

The following Table 10.2 summarizes the costs of the airport buildings associated with the proposed development of Nacala airport to handle the expected traffic according to international standards.

Table 10.2 Nacala Airport Building Construction Costs

	Unit	Quantity	Unit Cost (US$)	Subtotals		Total
				Import costs	Local costs	
Terminal Building	m^2	8,924	1,250	3,346,500	7,808,500	11,155,000
Contingencies						1,800,000
Terminal Building Sub-Total						12,955,000
ATC Tower	m^2	1,312	1,300	682,240	1,023,360	1,705,600
Contingencies						300,000
ATC Tower Sub-Total						2,005,600
ARFF-AMB	m^2	1,980	1,175	697,950	1,628,550	2,326,500
Contingencies						240,000
ARFF-AMB Sub Total						2,566,500
Cargo terminal	m^2	3,690	1,125	830,250	3,321,000	4,151,250
Contingencies						640,000
Cargo Building Sub Total						4,791,250
Grand Total Construction Cost						**$22,318,350**

The above table presents the complete costs of construction of the airport buildings required to handle the expected traffic in accordance with all acceptable standards. All of the buildings are designed as simple column-and–beam structures with insert panels and/or cement block walls between the columns. The ground floors will be constructed with a monolithic concrete pour between the columns, which can be expanded one bay at a time. The buildings can begin with the construction of a limited number of structural bays and then with additional bays built as the need demands. The above table also divides the costs into local and foreign components. The construction is concrete made of local materials and does not require extensive imported materials. Interior partitions and facilities could be added as the space expands. The designs include some features that could be omitted during construction, if necessary in order to reduce costs, such as a decorative front entrance, skylights, a chapel and a second level.

The following Table 10.3 presents the complete costs of the specialized equipment required to handle the expected traffic, including scheduled and charter airline services, at Nacala airport in accordance with all acceptable standards. It is assumed that most of the equipment listed in the following table will have to be imported to Mozambique. Although some of the equipment can be provided by the airlines that may routinely land at the airport, provisions must be made for seasonal and occasional charter flights.

Table 10.3 Nacala Airport Equipment Costs	
Passenger Terminal Equipment	
Baggage claim devices	$332,250
Outbound baggage system	$210,000
FIS inspection counters	$60,750
X-ray security screening	$352,875
Walk-through metal detectors	$31,500
Flight Information display systems	$98,250
Building Security Access Systems	$315,938
Sourcing, Shipping & Contingencies	$280,000
Subtotal Passenger Terminal Equipment	**$1,681,563**
ARFF Equipment	
ARFF foam tender, 4x4 chassis, 11,355 L water tank, 1515 L foam, 7570 L/min.	$562,500
ARFF foam tender, 4x4 chassis, 5,675 L water tank, 680 L foam, 3,785 L/min.	$375,000
RIV, 226 kg dry chemical, 1,900 L water, 225 L foam, 1,900 L/min, rescue tools	$307,500
Ambulance, including rescue tools	$165,000
6 fire entry suits & 6 fire fighting suits	$56,700
Sourcing, Shipping & Contingencies	$280,000
Subtotal ARFF Equipment	**$1,746,700**
Airport Maintenance Equipment	
Runway sweeper	$65,000
Plow & mower	$55,000
Tractors	$89,000
Garbage truck	$118,125
Sourcing, Shipping & Contingencies	$65,000
Subtotal Airport Maintenance Equipment	$392,125
Miscellaneous Equipment	
Generators (3)	$210,000
Carry-on luggage X-ray system	$66,150
Large luggage X-ray system	$42,525
Tower communications and surveillance equipment	$750,00
Ramp Safety and Service Equipment	$275,000
Meteorology equipment (minimal)	$60,000
Sourcing, Shipping & Contingencies	$87,000
Subtotal Miscellaneous Equipment	**$1,491,675**
Total Estimated Equipment Costs	**$5,311,363**

The following Table 10.4 shows the proposed phasing of the recommended capital expenditures at the Nacala air base in order to develop it as a civilian airport capable of handling the expected international airline traffic described in the previous sections of this report. The phasing of the recommended improvements is based on the forecast traffic as presented in Section 3.

The column labeled "sub-total basic project" represents the basic investments required to meet the safety and security needs of the airport, i.e. those elements to be installed or constructed during the planning period. It is expected that these costs would be financed by the cash flow of the project. The column labeled "sub-total ultimate project" represents the additional investments remaining to be completed later or provided by grants or soft loans if available. The "grand total" column on the right is the sum of the "sub-total basic project" and the "sub-total ultimate project" columns on the left.

Table 10.4 Nacala International Airport Costs and Phasing (US$x1000)

	2009	2013	2018	2028	Sub-total Basic Project	Sub-total Ultimate Project	Grand Total
Pax Terminal Building	3,887			3,887	7,773	5,182	12,955
ATC Building		501			501	1,504	2,006
ARFF-AMB Building		642	642		1,283	1,283	2,567
Cargo Terminal Building		1,198		1,198	2,396	2,396	4,791
Total Construction Cost	**3,887**	**2,341**	**642**	**5,084**	**11,953**	**10,365**	**22,318**
Pax Terminal Equipment		882	800		1,682		1,682
ARFF Equipment		600	600		1,200	547	1,747
Airport Maintenance Equip't		192	200		392		392
Miscellaneous Equipment		1,492			1,492		1,492
Total Equipment Cost	**0**	**2,196**	**1,600**	**0**	**3,796**	**547**	**4,343**
Airfield work	1,229		614	1,229	3,072	9,215	12,287
Site Work	1,135	3,406	568		5,109	6,244	11,353
Total Cost of Airfield	**2,364**	**3,406**	**1,182**	**1,229**	**8,181**	**15,459**	**23,640**
Total Development Cost	**6,251**	**7,943**	**3,424**	**6,313**	**23,930**	**26,372**	**50,301**

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SECTION 11 FINANCIAL FEASIBILITY ANALYSIS

11.1 Overall Financial Approach

This Section presents the financial analysis approach for the proposed Nacala Airport development program, which among other factors will assist ADM to formulate a plan for upgrading the airport to International Status and arranging financing to implement this plan. This financial analysis is based on conventional techniques utilized in the airport industry. Exhibit 11-1 depicts this approach, with steps completed in previous sections of the report displayed in green and steps completed in this section of the report displayed in yellow.

- **Traffic Forecasts** – These were developed in the Inception Report, as displayed in green in Exhibit 11-1. These traffic forecasts are used in the financial analysis to develop the operating revenue and operating expense projections presented later in this section of the Final Report.

- **Facility Requirements** – These were developed in the Inception Report, as displayed in green in Exhibit 11-1. They are used to develop operating revenue and operating expense projections, as well as the basis for developing the Financing Plan.

- **Financing Plan** – The financing plan is prepared as part of this financial analysis section of this Final Report, as displayed in yellow in Exhibit 11.1. The financing plan identifies the funding sources for the facility requirements, which includes contributions from ADM and external borrowings. It also identifies the debt service requirements for the external borrowing component.

- **Operating Revenue Projections** – These revenue projections are prepared as part of this financial analysis section of the Final Report, as displayed in yellow in Exhibit 11-1. These revenue projections are the same as the projections contained in the Inception Report, except that certain revenues have been enhanced based on the ICAO benchmarks explained below.

- **Operating Expense Projections** – These expense projections are prepared as part of this financial analysis section of the Final Report, as displayed in yellow in Exhibit 11-1. These expense projections are the same as the projections contained in the Inception Report, since the ICAO benchmarks relate only to revenues as explained below.

- **Cash Flow Projections** – These cash flow projections are prepared as part of this financial analysis section of the Final Report, as displayed in yellow in Exhibit 11-1.

These projections consists of combining the various financial elements, adding the revenue projections and subtracting the expense projections, the airport contributions, the interest requirements and the principal requirements, resulting in the net cash flow for the airport. The enhancement of revenues and the inflation of development costs are explained below.

- **Net Present Value and Internal Rate of Return Calculations** – These calculations of financial performance are prepared in the financial analysis, as displayed in yellow in Exhibit 11-1. The Net Present Value (NPV) represents the present value of the future cash flows, determined by discounting such cash flows by the Weighted Average Cost of Capital (WACC); if the NPV is positive, then the investment in the development program would be affordable, not considering the investor's (ADM) target investment rate. The IRR represents the discount rate that would equate the present value of the inflows with the present value of the outflows; if the IRR is higher than the investor's target investment rate, then the investment in the development program would be completely acceptable from the investor's (ADM) standpoint. These relationships, including the target IRR required by ADM, will be explained more thoroughly later in this section of the Final Report.

- **ICAO Revenue Benchmarks** – The ICAO revenue benchmarks are prepared as part of this financial analysis section of the Final Report, as displayed in yellow in Exhibit 11-1; this step was not completed in the Inception Report. These revenue benchmarks identify opportunities for increasing certain revenues for Mozambique that are below industry standards for Africa. These opportunities are determined by comparing tariff structures for Mozambique and other African nations, using International Civil Aviation Organization (ICAO) data. It should be noted that the enhanced revenues are used in the cash flow projections.

- **Currency Inflation Factors** – The currency inflation factors are prepared as part of this financial analysis section of the Final Report, as displayed in yellow in Exhibit 11.1; likewise, this step was not completed in the Inception Report. These inflation factors identify certain cost increases that would occur based on the assumption that the development program would be staged over the 2009-2028 projection period. These increases are determined by applying inflation rates to the development requirements, using prevailing inflation rates in Mozambique for the local cost components and in the United States for the foreign exchange components. Likewise, it should be noted that the inflated development costs are used for calculation of the financing requirements used in the cash flow projections.

11.2 Financial Analysis

This section presents the financial analysis for Nacala Airport and includes subsections regarding the Financing Plan, the Operating Revenue projections, the Operating Expense projections, the Cash Flow projections and the NPV and IRR calculations.

11.2.1 Financing Plan

Sources of Financing

As explained in the Section 5 (Legal Framework) of the present Final Report, it is not likely that commercial lenders would be prepared to extend loans in Mozambique that would normally be secured by liens or mortgages, since the laws and regulations in force in Mozambique preclude foreclosure on property. In particular, Subsection (3)of Article 20 of the Corporate Charter of ADM which is attached to Decree 3/98 specifically limits ADM from alienating, mortgaging or otherwise encumbering facilities on the properties it manages.

Therefore, for numerous reasons a foreclosure on airport property is simply not feasible and thus the financing of any airport project in Mozambique will need to be either by a Build-Operate-Transfer concession from ADM, credits from suppliers, soft loans from a Development Bank, or a sovereign state guarantee from the Government.

Also, as a practical matter, lenders probably would not be prepared to extend loans in Mozambique secured by pledges of revenue streams, because of the economic status and perceived risk of the country and region. Therefore, loans secured by Sovereign Guarantees by the Government of Mozambique would represent the only viable alternative. For this reason, the financing plan presented in this report includes known lenders that would accept Mozambique Sovereign Guarantees as security for their loans.

This does not mean that other sources of financing would not be available to ADM; these are discussed in Section 11.3 of the main report. In order to present a realistic financial analysis based on known factors, however, we have developed the Financing Plan on the basis of the sources described in the following paragraphs.

<u>African Development Bank</u>

The African Development Bank (AfDB) provides a variety of financing programs for the construction components of development projects in Africa, including Mozambique. These financing programs include risk management products, bank guarantees, public and private sector loans without sovereign guarantees and public sector loans with sovereign guarantees. AfDB loans secured by Mozambique Sovereign Guarantees represent the arrangement included in this financing plan, and would include the following basic terms and conditions:

- **Repayment Term** – The maximum repayment period may extend as long as 20 years, and this would be inclusive of a maximum grace period for as long as 5 years. This financial analysis assumes a 15-year repayment term, without any grace period.

- **Interest Rate** – The interest rate is based on a fixed rate, reflecting the Commercial Interest Reference Rate (CIRR) system, with a base rate corresponding to the yield

to maturity on 3-year United States Treasury Bonds plus a 1% lending margin. This financial analysis assumes a fixed interest rate of 8%.

- **Sovereign Guarantee** – As noted above, this AfDB arrangement would be predicated on security in the form of a sovereign guarantee by Mozambique to the AfDB for the life of each loan.

- **Loan to Equity Ratio** – With security provided by a sovereign guarantee, there would be no particular equity requirement. This financial analysis, however, assumes that ADM would provide a substantial equity component for each AfDB loan, as demonstrated in the following section.

United States Export-Import Bank

The Export-Import Bank of the United States (US EX-IM) also provides a variety of financing programs for the United States export requirements of construction projects in Africa, likewise including Mozambique (this analysis assumes that all exports would be supplied by United States manufacturers). These financing programs include repayment guarantees and risk insurance supporting loans extended by others to importers. They also include loans extended by US EX-IM directly to importers, and security arrangements for the direct loans may include sovereign guarantees. Direct US EX-IM loans secured by Mozambique Sovereign Guarantees represent the arrangement included in this financing plan, and would include the following basic terms and conditions:

- **Repayment Term** – Ordinarily, the maximum repayment requirement may extend as long as 7 years, and under extraordinary condition it may exceed 7 years. This financial analysis assumes a 5-year repayment term.

- **Interest Rate** – The interest rate requirement is based on a fixed rate, reflecting the Commercial Interest Reference Rate (CIRR) system, with a base rate corresponding to the yield to maturity on 3-year United States Treasury Bonds plus a 1% lending margin. This financial analysis assumes a fixed interest rate of 8%.

- **Sovereign Guarantee Security** – As noted above, this US EX-IM arrangement would be predicated on security in the form of a sovereign guarantee by Mozambique to the US EX-IM for the life of each loan.

- **Loan to Equity Ratio** – Even with security provided by a sovereign guarantee, US EX-IM under current practices would provide loans for only an 85% share of the United States export requirements. This financial analysis assumes that ADM contributions would provide the remaining 15% share of these requirements.

Development of Financing Requirements

Table 11-1 has been prepared to determine the development of the financing requirements that will be used in the cash flow analysis later in this section of the Final Report. Table 11-1 includes four components, each of which is described below:

- **Un-inflated Cost Requirements** – These include three elements, which are landside construction costs, airside construction costs and equipment import costs. In summary, the total cost is US$ 23,392,000, consisting of US$ 11,955,000 for landside construction costs, US$ 8,181,000 for airside construction costs and US$ 3,796,000 for equipment import costs. These un-inflated costs also identify the currency requirements (foreign currency and local currency) and the staging requirements (2009, 2013, 2018 and 2028), which are used to develop the financing requirements below.

- **Un-inflated Financing Plan** - This includes four elements, which are (1) AfDB loans for the foreign exchange share of the landside/airside construction projects, (2) ADM contributions for the local share of the landside/airside construction projects, (3) US EX-IM loans for the 85% share of the equipment import requirements and (4) ADM contributions for the remaining 15% share of the equipment import requirements. In summary, the total un-inflated financing requirement is US$23,392,000, with AfDB loans of US$8,940,700 and ADM contributions of US$11,195,300 for the landside/airside construction requirements, and US EX-IM loans of US$3,226,600 and ADM contributions of US$569,400 for the equipment import requirements. AFDB's share of these financing requirements is 37%, US EX-IM's share is 13% and ADM's combined share is 50%, for an overall 50/50 loan /equity ratio.

- **Inflated financing plan** – This is accomplished by multiplying the foreign currency requirements by the prevailing inflation rate in the United States and the local currency requirements by the prevailing inflation rate in Mozambique. This analysis uses inflation rates of 2.5% for foreign currency requirements and 6.5% for local currency requirements (prevailing inflation rates in the United States and Mozambique, respectively). Also, this conversion applies the inflation rates on a compounded basis, reflecting the staging of the development projects over the 20-year projection period (2009, 2013, 2018 and 2028). On this basis, the total inflated financing requirement is US$40,938,987, with the landside/airside construction requirements funded with AfDB loans of US$11,482,582 and ADM contributions of US$24,546,866, and equipment import requirements funded with US EX-IM loans of US$3,949,122 and ADM contributions of US$960,438. AfDB's share of these financing requirements is 28%, US EX-IM's share is 10% and ADM's combined share is 62%, for an overall 38/62 loan/equity ratio. It should be noted that the loan/equity ratio is lower for the inflated financing requirements than for the un-inflated financing requirements, reflecting the different inflation rates used for the foreign currency and the local currency requirements. This has the effect of increasing the discount rate used in the cash flow analysis presented later in this section of the Final Report, which depresses the financial performance of the project as developed therein.

- **Debt service requirements** - This consists of calculating the interest and principal requirements for the AfDB and US EX-IM loans that are used in the cash flow projections later in this section of the Final Report. This calculation is based on the terms and conditions covered above for these loan arrangements, which are 15-year repayment terms and 8% interest rate requirements for the AfDB loans and 5-year repayment terms and 8% interest rate requirements for the US EX-IM loans, with each requirement commencing in the year following completion of the development projects, i.e., interest and principal requirements for the 2009 projects would commence in 2010, etc.. As shown, the total interest requirements are US$10,539,850 and the total principal requirements are US$10,695,328. Also, as shown, the US EX-IM loans with 5-year repayment terms are completely repaid at the end of the 20-year projection period, while the AfDB loans for the 2018 and 2028 project stages have outstanding balances of US$4,736,355 as of the end of 2028, the end of the 20-year projection period. Theses outstanding balances, of course, cannot be taken into consideration in the cash flow analysis presented later in this section of the Final Report.

11.2.2 Operating Revenues

Operating Revenue Enhancements:

Exhibits 11-2A, B, C and D display comparisons for two (2) categories of aeronautical revenues and for nineteen (19) African countries. The two categories are Landing Fee Charges and Passenger Related Charges, which together embrace all of the aeronautical charges for airports. The 19 African countries are Mozambique, Algeria, Burkina Faso, Cameroon, Cote d'Ivoire, Ethiopia, Ghana, Kenya, Madagascar, Mali, Mauritius, Nigeria, Senegal, Seychelles, South Africa, Togo, Tunisia, Uganda and Zimbabwe. This Exhibit includes two charts for each category, the first showing the total revenues for the 19 countries and the second showing the variation from the average for the 18 other countries. As shown in Exhibit 11-2B, the average for Landing Fee Charge is US$1.41 higher for the 18 other countries than for Mozambique, providing an indication that there are certain opportunities for enhancing the revenue sources for Mozambique. The average for the Passenger Related Charges, as shown in Exhibit 11-2D, is US$19.55 higher for the 18 other countries than for Mozambique, likewise providing an indication that certain revenue enhancements could be introduced for Mozambique.

Exhibits 11-3A and B through Exhibits 11-10A and B display 8 revenue categories, comparing tariffs in Mozambique with those in the 18 other countries in Africa. Each Exhibit contains data calculating the tariff rate on a common denominator and two charts, the first showing the total revenues for Mozambique and the other 18 other countries in Africa, and the second showing the variation from the average for all 19 airports. Three of these charts demonstrate that the average tariff is higher than the Mozambique tariff, creating the basis for revenue enhancements for Mozambique. Two of these charts identify tariffs that are charged in several of the other African countries, but not in Mozambique, likewise creating the basis for revenue enhancements for

Mozambique. In order to be conservative, this analysis limits the enhancements to 75% of the average variation, and introduces one-half of the enhancements in 2011 and the other one-half in 2020, two full years following the completion of the Stage I and Stage III development projects. As indicated earlier, these comparisons have been developed based on ICAO data, and are summarized below.

- **Landing Charges (US$ per Operation)** – Exhibits 11-3A and B demonstrate that the average tariff is 2.01 times the Mozambique tariff. This revenue source has been enhanced by 1.51 times, with the adjustment split between in 2011 and 2020 as indicated above.

- **Parking Charges (US$ per Operation)** – Exhibits 11-4A and B demonstrate that the average tariff is 7.41 times the Mozambique tariff. This revenue source has been enhanced by 5.56 times, with the adjustment split between 2011 and 2020 as indicated above.

- **Passenger Service Charges (US$ per Passenger)** – Exhibits 11-5A and B demonstrate that the average tariff is 1.38 times the tariff in Mozambique. This revenue source has been enhanced by 1.04 times, with the adjustment split between in 2011 and 2020 as indicated above.

- **Cargo Charges (US$ per Ton)** – Exhibits 11-6A and B demonstrate that the average tariff is only 0.49 times the Mozambique tariff. This revenue source, therefore, has <u>not</u> been enhanced.

- **Fuel Charges (US$ per Liter)** – Exhibits 11-7A and B demonstrate that the average tariff is 0.99 times the Mozambique tariff. This revenue source, therefore, has <u>not</u> been enhanced.

- **Lighting Charges (US$ per Operation)** – Exhibits 11-8A and B demonstrate that the average tariff is US$139, while there is no corresponding charge in Mozambique. This revenue source has been enhanced by US$104, with the adjustment split between 2011 and 2020 as indicated above.

- **Security Charges (US$ per Passenger)** – Exhibits 11-9A and B demonstrate that the average tariff is US$3.43, while there is no corresponding charge in Mozambique. This revenue source has been enhanced by US$2.57, with the adjustments split between 2011 and 2020 as indicated above.

- **Hangar Charges (US$ per Operation)** – Exhibits 11-10A and B demonstrate that the average tariff is only 0.26 times the Mozambique tariff. This revenue source, therefore, has <u>not</u> been enhanced. It should be noted that the available airport accounting records combine hanger charges and other rental charges, although they should be segregated because the hanger charges are aeronautical revenues while the other rental charges are non-aeronautical revenues.

Operating Revenue Projections:

Table 11-2 presents the Operating Revenue projections for Nacala Airport. As explained previously in Section 4 of this report, Nacala Airport would not commence operations as a civil airport until 2010. Operating Revenues for Nacala Airport in 2010 are based on operating revenues for Pemba Airport in 2010, as developed in Section 4, with adjustments reflecting the differences in air traffic projections for the two airports in 2010. Operating Revenues for Nacala Airport are consistent with ICAO requirements, with aeronautical revenues payable in US dollars and non-aeronautical revenues payable in local currency. As shown, Operating Revenues are projected to increase from US$792,000 in 2010 to US$17,193,000 in 2028, representing an average annual growth rate of 18.65%. On a per enplaned passenger basis, Operating Revenues increase from US$23.98 in 2010 to US$75.57 in 2028, or an average annual growth rate of 6.59%.

In general, each of these Operating Revenue projections reflect inflation, which is applied at five-year intervals over the 2010 through 2028 projection period at the compounded rate of 17.34%, corresponding to 50 % of the recent annual inflation rate in Mozambique of 6.50%; inflation is not necessarily mentioned again below. Also, these revenue projections reflect growth of aviation traffic and expansion of aeronautical facilities, as appropriate. Nacala Airport has eleven revenue elements, and the assumptions used to develop projections for each element are reviewed below:

- **Landing Charges** – These charges are payable in US dollars and based on the maximum take-off weight (MTOW) of aircraft arrivals, with different rates applicable to the three categories of airports in Mozambique. Nacala Airport would be included in the Airport category from commencement of civil operations in 2010. Also, these projections reflect the level of aircraft operations each year, since the traffic projections do not include calculation of MTOW. Landing Charges are projected to increase from US$66,000 in 2010 to US$1,140,000 in 2028, corresponding to a 17.17% average annual growth rate. It should be noted that these revenue projections include the revenue enhancements covered in the preceding section.

- **Parking Charges** – These charges are payable in US dollars and based on MTOW for aircraft parked in excess of 90 minutes. These projections, like above, do not reflect rate increases, since the airport category would not change, and they are uniform for all three airport categories as well. Also, like above, these projections reflect the projected level of operations, since the traffic projections do not include calculation of MTOW. Parking charges are projected to increase from US$8,000 in 2010 to US$517,000 in 2028, or an average annual growth rate of 25.97%. It should be noted that these revenue projections include the revenue enhancements covered in the preceding section.

- **Passenger Charges** – These charges are payable in US dollars and based on the level of departing passengers for scheduled and non-scheduled flights, with different rates applied to domestic, regional and international destinations. These projections reflect an average rate and projected passenger levels. As shown, Passenger

Charges are projected to increase from US$304,000 in 2010 to US$5,810,000 in 2028, corresponding to a 17.81% average annual growth rate. It should be noted that these revenue projections include the revenue enhancements covered in the preceding section.

Cargo Charges – These charges are payable in US dollars and based on the weight (kg) of the cargo and mail loaded and unloaded at the airport. These projections reflect the current rate and the projected cargo and mail traffic. As shown, Cargo Charges increase from US$12,000 in 2010 to US$43,000 in 2028, or a 7.31% average annual growth rate.

- **Air Navigation Charges** – These charges are payable in US dollars and based on the MTOW for aircraft that are arriving or departing and serviced by the control tower facilities at Nacala Airport. As with Landing Charges and Parking Charges, these projections reflect projected aircraft operations because MTOW calculations have not been developed the report. As shown, Air Navigation charges are projected to increase from US$28,000 in 2010 to US$317,000 in 2028, corresponding to a 14.53% average annual growth rate.

Fuel Charges – These charges represent fuel throughput fees, are payable in US dollars and are based on hectoliters of aviation fuel sold to aircraft using Nacala Airport. Since aviation fuel has not been projected elsewhere in the Inception Report, these projections reflect the projected aircraft operations throughout the 2010 through 2028 projection period. As shown, Other Service Charges are projected to increase from US$3,000 in 2010 to US$122,000 in 2028, corresponding to a 22.13% average annual growth rate.

- **Lighting Charges** – These charges will be payable in US dollars, and based on the maximum take-off weight (MTOW) of aircraft arrivals, with different rates applicable to three categories of airports. These projections do not reflect rate increases, since the airport category for Nacala Airport would not change as mentioned above and the rates are uniform for all three airport categories as well. Also, like above, these projections reflect the projected level of aircraft operations, since MTOW calculations have not been developed in this report. As shown, Lighting Charges, which are projected to commence in 2011, would increase from US$189,000 in 2011 to US$1,307,000 in 2028, or an average annual growth rate of 12.03%. It should be noted that these charges represent a new revenue source for Nacala Airport, reflecting the revenue enhancements covered in the preceding section.

- **Security Charges** - These charges will be payable in US dollars and based on the level of departing passengers for scheduled and non-scheduled flights, with different rates applied to domestic, regional and international destinations. These projections reflect an average rate and projected passenger levels. As shown, Security Charges, which also are projected to commence in 2011, would increase from US$72,000 in 2011 to US$584,000 in 2028, corresponding to a 13.11% average annual growth rate. It should be noted that these charges represent a new revenue

source for Nacala Airport, reflecting the revenue enhancements covered in the preceding section.

- **Rental Charges** – These charges are payable in local currency and based on rentable space in the terminal and hangar facilities. These projections reflect increased rates and expanded space for the terminal and hangar facilities from 2010 through 2028 when the staged development program occurs. As shown, Rental Charges are projected to increase from US$249,000 in 2010 to US$3,770,000 in 2028, corresponding to a 16.29% average annual growth rate. As noted above, in the future, Rental Charges should be segregated, with terminal rentals treated as non-aeronautical revenues, as they are at present, and hangar rentals treated as aeronautical revenues.

- **Usage Charges** – These charges are payable in local currency and based on percentages of the gross revenues of the service providers at the airport, such as terminal concessionaires. These projections are based on projected rate increases and passenger levels, since details of the terminal concession program have not been developed at this point. As shown, Usage Charges are projected to increase from US$104,000 in 2010 to US$3,530,000 in 2028, corresponding to a 21.61% average annual growth rate.

- **Miscellaneous Charges** – These charges are payable in local currency and based on inflation only. As shown, Other Service Charges are projected to increase from US$17,000 in 2010 to US$154,000 in 2028, corresponding to a 6.50% average annual growth rate.

11.2.3 Operating Expenses Projections

Table 4-3 presents Operating Expense projections for Nacala Airport. As with the Operating Revenues, the Operating Expenses commence in 2010 and are based on operating expenses for Pemba Airport in 2010, as developed in the Section 4 (Comparative Financial Analysis) of this report, with adjustments reflecting the differences in aviation traffic projections for the two airports in 2010. As shown, total Operating Expenses increase from US$821,000 in 2010 to US$3,222,000 in 2028, representing an average annual growth rate of 7.89%. On a per enplaned passenger basis, Operating Expenses decrease from US$25.00 in 2010 to US$14.00 in 2028, or an average annual growth rate of minus 3.33%. Effectively, these projections reflect higher growth rates for passenger departures than for Operating Expenses during this period.

In general, each of these Operating Expense projections reflect inflation which, as with Operating Revenues, is applied at five-year intervals over the 2010 through 2028

projection period at the compounded rate of 17.34%, corresponding to 50% of the recent annual inflation rate in Mozambique of 6.50%. Also, these expense projections reflect growth in aviation traffic, expansion of aeronautical facilities, and establishment of an

organization, whichever is relevant. Nacala Airport has four expense elements, and the assumptions used to develop projections for each element are reviewed below:

- **Personnel Costs** – Personnel Costs are payable in local currency and are based on the number and level of employees. Exhibits 11-11A and B represent two Organization Charts for Nacala Airport. The top chart reflects 2010, the first year of operation, while the bottom chart reflects 2014, four years thereafter. Otherwise, both charts are the same, showing nine functions and the proposed employees for each function. These staffing levels assume that there would be three shifts of eight hours per day, with each department (except the Airport Manager) having at least one staff per shift, as follows:

Airport Manager	1 employee	= 1
Administration	3 shifts x 1 employee	= 3
Control Tower	3 shifts x 4 employees	= 12
Flight Information	3 shifts x 1 employee	= 3
Fire fighters	3 shifts x 8 employees	= 24
Electronics Maintenance	3 shifts x 1 employee	= 3
Electrical Maintenance	3 shifts x 2 employees	= 6
Civil Works Maintenance	3 shifts x 2 employees	= 6
Terminal Custodial Maintenance	3 shifts x 4 employees	= 12
Total Employees		= 70

  Personnel costs, which reflect inflation only, are projected to increase from US$784,000 in 2010 to US$2,435,000 in 2028, representing an average annual growth rate of 6.50%.

- **Supply Costs** – Supply Costs, representing the costs for the procurement of all of the materials consumed by the departments of the airport, are payable in local currency. Since the various components have not been provided by ADM, these projections are based on projected traffic operations, as well as inflation rates. As shown, supply costs are projected to increase from US$19,000 in 2010 to US$426,000 in 2028, corresponding to an 18.76% average annual growth rate.

- **Contract Service Costs** – Contract Service Costs, representing the costs of outsourcing of all of the services not provided by the airport or ADM, are payable in local currency. Again, since ADM has not provided details, these projections are based on projected traffic operations as well as inflation rates. As shown Contract Service Costs are projected to increase from US$8,000 in 2010 to US$185,000 in 2028, or an 18.76% average annual growth rate.

- **Finance Costs** – Finance Costs represent the costs associated with financial activities such as banking and are payable in local currency; interest costs on external borrowing for the development program, will not be included in this expense category, but alternatively will be included in the cash flow projections as separate line items. Since ADM has not provided details, the projections are based on

inflation only. Finance Costs are projected to increase from US$1,000 in 2010 to US$4,000 in 2028, corresponding to a 6.50% average annual growth rate.

- **Administrative Fee Costs** – Administrative Fee Costs represents the charge that the airport pays to ADM for services provided, including accounting, legal and personnel activities. The Administrative Fee is established by ADM and the current rate is 1.0% of the airport's Operating Revenues, which are affected by expansion of certain facilities, increase of certain rates, enhancement of certain revenues and impacts of inflation. As such, this expense increases from US$8,000 in 2006 to US$172,000 in 2028, or an 18.65% average annual growth rate.

11.2.4 Cash Flow Projections and NPV and IRR Calculations

This Section of the Report presents the financial outcome for Nacala Airport. It also presents measures of financial performance that will assist ADM in deciding whether to upgrade Nacala Airport to International Status and in arranging financing for the proposed development program. These financial performance measures are presented in Table 11-4, and include Net Cash Flow (NCF), Weighted Average Cost of Capital (WACC), Net Present Value (NPV) and Internal Rate of Return (IRR), each of which is discussed below:

- **Net Cash Flow (NCF)** – Table 11-4 presents NCF for Nacala Airport, showing a positive value of US$55,001,000 over the 2009 through 2028 projection period, implying that the proposed development program would be affordable, although this result does not take into consideration the time-adjusted value of financing the development program. The Weighted Average Cost of Capital, the Net Present Value and the Internal Rate of Return, each of which is discussed below, address this issue.

- **Weighted Average Cost of Capital (WACC)** – Table 11-4 presents the WACC, which has been determined by blending the actual cost of the external borrowing (8% for both AfDB and US EX-IM loans) and the opportunity cost of the investor contribution (18% for ADM), and weighting these costs by the proportions borrowed (38%) and contributed (62%), respectively. As shown, the Weighted Average Cost of Capital is 13.81%.

- **Net Present Value (NPV)** – Table 11-4 presents the NPV, representing the NCF discounted by the WAAC, showing a positive value of US$4,264,000 over the 2009 through 2028 projection period. This performance measure indicates that the proposed development program for the airport would be <u>affordable</u>, but not necessarily <u>acceptable</u>, since it only demonstrates that the return would exceed the financing cost. It is entirely conceivable that the Net Present Value could be a negative value, which would mean that the proposed development program would be neither affordable nor acceptable.

- **Internal Rate of Return (IRR)** - Finally, Table 11-4 presents the IRR, representing the discount rate that would equate the present value of the inflows with the present value of the outflows. As shown, the IRR is 20.24% over the 2009 through 2028 projection period. This performance measure indicates that the proposed development program would be both affordable and acceptable, because it demonstrates that the return would exceed both the financing cost (13.81%) and the ADM target investment rate (18%).

11.3 Summary and Conclusions

11.3.1 Financial Analysis Conclusions

In conclusion, the foregoing financial analysis has demonstrated that ADM would be justified in upgrading Nacala Airport to International Status, based on the financial performance measures explained above. Specifically, the proposed development program would be both affordable (the 20.24% IRR would exceed the 13.81% WACC) and acceptable (the 20.24% IRR would also exceed the 18.00% ADM target investment rate).

11.3.2 Alternative Sources of Financing

Section 10.2.1 (Financial Plan) identified the African Development Bank (AfDB) and the United States Export-Import Bank (US EX-IM) as sources of financing for the purpose of the present analysis. This being said, other possibilities may exist in addition to these known sources.

Commercial Capital Markets

In developed countries such as the US, the UK and Canada, commercial capital markets provide a number of instruments for the financing of airport development projects. In the US and Canada Airport Revenue Bonds form an important component of the financial planning of airport authorities. These are usually syndicated loans which are sold to the public and guaranteed by the forecast revenue stream of the airport operating authority or by the local level of government that owns the airport (municipality, county or state). Holders of these instruments often benefit from tax advantages accruing to the interest earned on bonds issued by public entities.

It is unlikely that such a relatively sophisticated instrument would be applicable for the financing of the proposed Nacala airport development program. First, Nacala airport has no historical revenue stream to serve as a basis for evaluation by prospective lenders. Second, the use of tax-exempt syndicated bonds issued by Mozambican authorities in general and airport operators such as ADM in particular does not appear to be current practice to our knowledge. Third, the perceived risk to borrowers and underwriters would probably lead to rates of interest which would be significantly higher than those charged by the sources identified in Section 10.2.1. Finally, the level of borrowing that

would be required is not likely to attract lenders to develop such a relatively complex mechanism in the current Mozambican context.

State Subsidies

Both the US and Canada have put into place mechanisms to support airport authorities by means of direct state subsidies for the purpose of airport development. In the US, the Airport Improvement Program (AIP) provides grants to local airport authorities for capital expenditures related to projects aimed at the expansion of airside capacity and aviation safety and security. A similar instrument in Canada is known as the Airports Capital Assistance Program (ACAP). In both cases, the grants are subject to restrictions. They can only be used for certain well-defined projects and in the US, the AIP grants are only available to airport authorities which adhere to strict rules regarding limits on passenger facility charges, which form a significant portion of the airport revenues in Mozambique.

The logic behind both these programs is that basic airport facilities which improve airside capacity, safety and security represent part of the country's transportation infrastructure and therefore should be considered as benefits to the entire population. The central government thus is justified in investing in these assets. In the case of Mozambique, the legislation which created and governs the activities of ADM envisages the possibility of direct investment in airport infrastructure by the central government.

Private Sector Direct Investment

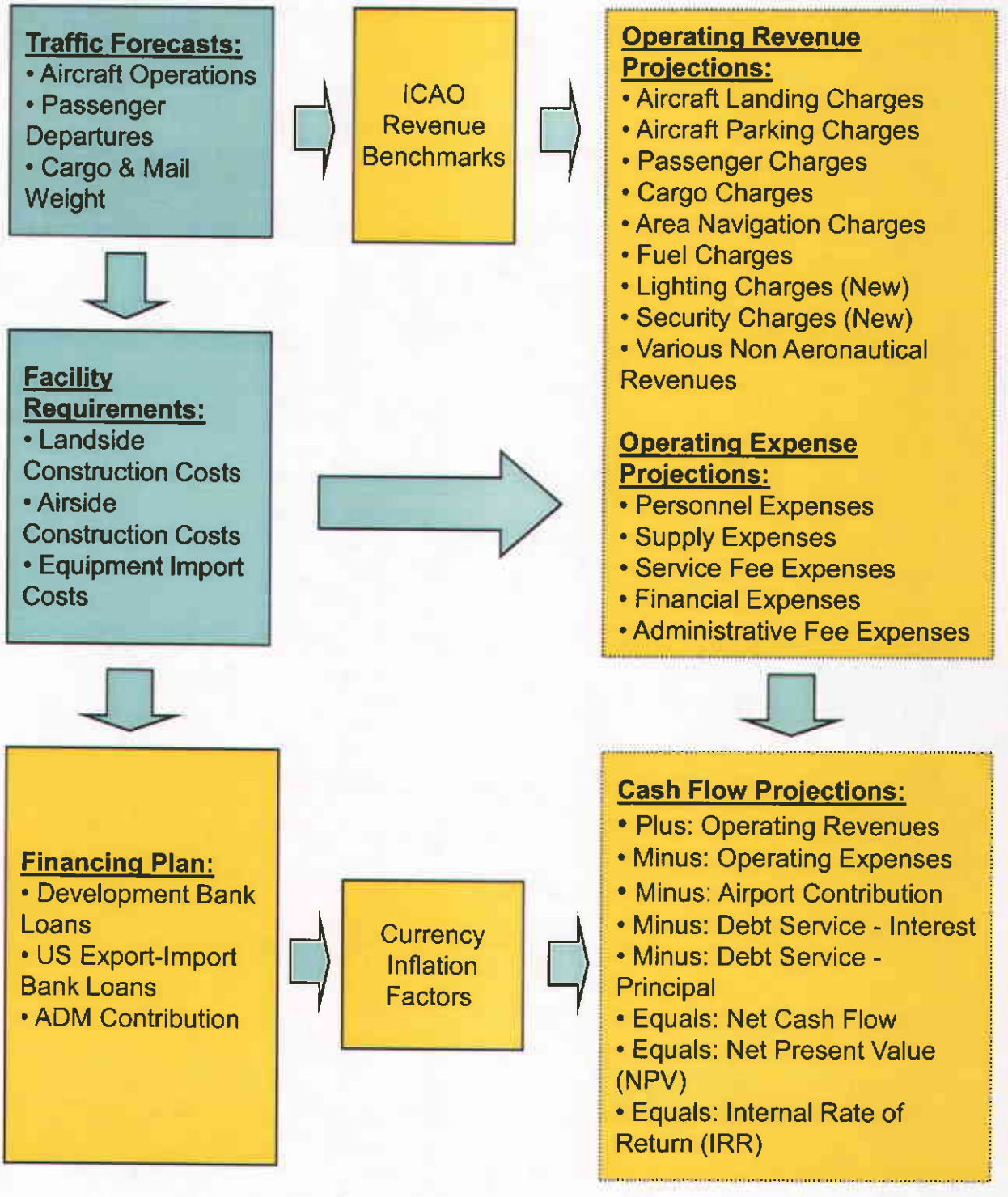
Direct investment in airport development by the private sector has increased significantly over the past few years, primarily under two principal mechanisms: (1) airport development/operating concessions, and (2) equity participation in airport authorities.

In the case of an airport development/operating concession, the prospective concessionaire assumes the responsibility of building, financing, operating and maintaining the facilities in question in return for the right to retain the major portion of the airport revenues (minus a royalty typically paid to the conceding authority). This type of arrangement can include entire airports or significant portions of airports, such as passenger terminals. In Africa, this mechanism has been implemented in a number of (primarily francophone) countries, with mixed results. In Madagascar, Cameroon and Gabon, the investments made by the concessionaire did not meet the respective governments' expectations and in all cases the concession contracts are being revised at considerable cost. In Côte d'Ivoire, it is the concessionaire who has experienced disappointing results due to decline in traffic and disruption occasioned by the civil war. In Senegal, the government has initiated a "BOT" concession for the construction of a new "greenfield" airport to replace the existing international serving the capital airport at Dakar. At present it is impossible to say whether the project will be successful since the project is still in the early stages of completion.

In the case of equity participation, airport authorities are able to raise capital by selling shares either to the public (the case of British Airports Authority) or to selected technical and financial partners (the case of Airports Company of South Africa). This approach requires the airport authority to first transform itself into a true public/private corporate entity with the possibility of private shareholding. A number of other African countries are considering this approach, including Ghana; however, the exercise there has not been completed so the results cannot be evaluated.

In our opinion, neither of these options are applicable to the case of the Nacala airport development program. First, the Nacala project by itself is probably too small to attract the interest of serious airport operator investor/operator in the form of a BOT concession. Second, the creation of an independent corporate entity to take over a portion of the existing military is probably impossible under Mozambican law. Third, the transformation of ADM into a corporate entity with the possibility of private shareholding is probably not possible within the time frame envisaged for the implementation of the proposed Nacala development program. Finally, the perceived risk to investors would probably lead to a requirement for internal rates of return (IRRs) which would be in the order of at least 22%, i.e. higher than those achieved in the financial analysis presented above in the present Section 11.

Exhibit 11-1
Financial Analysis Approach



Source: ARROTEC

Table 11-1
Nacala Airport Financing Plan

Development Costs	% Distribution	Actual 2006	Forecast 2007	Forecast 2008	Forecast 2009	Forecast 2010	Forecast 2011	Forecast 2012	Forecast 2013	Forecast 2014	Forecast 2015	Forecast 2016	Forecast 2017	Forecast 2018	Forecast 2019	Forecast 2020	Forecast 2021	Forecast 2022	Forecast 2023	Forecast 2024	Forecast 2025	Forecast 2026	Forecast 2027	Forecast 2028	Total 2006-2028	total 2006-2028 (3 Categories)
Landside Construction Costs:																										$ 11,955,000
Terminal Building - US$	0.30	$ -	$ -	$ -	$ 1,166,100	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,166,100	$ 2,332,200	
Terminal Building - LC	0.70	$ -	$ -	$ -	$ 2,720,900	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 2,720,900	$ 5,441,800	
ATC Tower - US$	0.40	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 200,400	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 200,400	
ATC Tower - LC	0.60	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 300,600	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 300,600	
ARFF-AMB - US$	0.30	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 192,600	$ -	$ -	$ -	$ -	$ 192,600	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 385,200	
ARFF-AMB - LC	0.70	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 449,400	$ -	$ -	$ -	$ -	$ 449,400	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 898,800	
Cargo Terminal - US$	0.20	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 239,600	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 239,600	$ 479,200	
Cargo Terminal - LC	0.80	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 958,400	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 958,400	$ 1,916,800	
Airside Construction Costs:						$ -	$ -	$ -		$ -	$ -	$ -	$ -		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -			$ 8,181,000
Site Work - US$	0.55	$ -	$ -	$ -	$ 658,300	$ -	$ -	$ -	$ 1,675,450	$ -	$ -	$ -	$ -	$ 329,440	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 2,963,220	
Site Work - LC	0.42	$ -	$ -	$ -	$ 476,700	$ -	$ -	$ -	$ 1,430,520	$ -	$ -	$ -	$ -	$ 238,560	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 2,145,780	
Paving - US$	0.84	$ -	$ -	$ -	$ 1,032,360	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 515,760	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,032,360	$ 2,580,480	
Paving - LC	0.16	$ -	$ -	$ -	$ 196,640			$ -	$ -	$ -	$ -	$ -	$ -	$ 98,240	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 196,640	$ 491,520	
Equipment Import Costs:						$ -	$ -	$ -		$ -					$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -			$ 3,796,000
Passenger Terminal - US$	0.85	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 749,700	$ -	$ -	$ -	$ -	$ 680,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,429,700	
Passenger Terminal - LC	0.15	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 132,300	$ -	$ -	$ -	$ -	$ 120,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 252,300	
ARFF-AMB -US$	0.85	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 510,000	$ -	$ -	$ -	$ -	$ 510,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,020,000	
ARFF-AMB -LC	0.15	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 90,000	$ -	$ -	$ -	$ -	$ 90,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 180,000	
Maintenance - US$	0.85	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 163,200	$ -	$ -	$ -	$ -	$ 170,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 333,200	
Maintenance - LC	0.15	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 28,800	$ -	$ -	$ -	$ -	$ 30,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 58,800	
Miscellaneous - US$	0.85	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 443,700	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 443,700	
Miscellaneous -LC	0.15	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 78,300	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 78,300	
Total Development Costs		$ -	$ -	$ -	$ 6,251,000	$ -	$ -	$ -	$ 7,943,000	$ -	$ -	$ -	$ -	$ 3,424,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 6,314,000	$ 23,932,000	$ 23,932,000
Financing Plan - Present Costs (2007)																										% of Total
ADB Debt (US$ Share Construction Costs)		$ -	$ -	$ -	$ 2,856,760	$ -	$ -	$ -	$ 2,608,080	$ -	$ -	$ -	$ -	$ 1,037,800	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 2,438,060	$ 8,940,700	37%
ADM Share (LC Share Construction Costs)		$ -	$ -	$ -	$ 3,394,240	$ -	$ -	$ -	$ 3,138,820	$ -	$ -	$ -	$ -	$ 786,200	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 3,875,940	$ 11,195,300	47%
Exim Bank Credit (US$ Share Equipment Costs)		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,866,600	$ -	$ -	$ -	$ -	$ 1,360,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 3,226,600	13%
ADM Share (LC Share Equipment Costs)		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 329,400	$ -	$ -	$ -	$ -	$ 240,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 569,400	2%
Total Financing Sources - Uninflated Costs		$ -	$ -	$ -	$ 6,251,000	$ -	$ -	$ -	$ 7,943,000	$ -	$ -	$ -	$ -	$ 3,424,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 6,314,000	$ 23,932,000	100%
Financing Plan - Inflated Costs (2007-2028)																										
ADB Debt (US$ Share Construction Costs)		$ -	$ -	$ -	$ 3,001,383	$ -	$ -	$ -	$ 3,024,573	$ -	$ -	$ -	$ -	$ 1,361,684	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 4,094,921	$ 11,482,562	28%
ADM Share (LC Share Construction Costs)		$ -	$ -	$ -	$ 3,649,832	$ -	$ -	$ -	$ 3,580,131	$ -	$ -	$ -	$ -	$ 1,571,733	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 14,945,170	$ 24,546,866	60%
Exim Bank Credit (US$ Share Equipment Costs)		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 2,164,684	$ -	$ -	$ -	$ -	$ 1,784,438	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 3,949,122	10%
ADM Share (LC Share Equipment Costs)		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 480,641	$ -	$ -	$ -	$ -	$ 479,798	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 980,438	2%
Total Financing Sources - Inflated Costs		$ -	$ -	$ -	$ 6,651,215	$ -	$ -	$ -	$ 10,250,029	$ -	$ -	$ -	$ -	$ 5,197,651	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 18,640,092	$ 40,938,987	100%
ADB Debt Service Requirements - 2009 Projects:																									Interest	Total 2006-2028 Principal
Interest Requirement		$ -	$ -	$ -	$ -	$ 240,111	$ 231,268	$ 221,717	$ 211,402	$ 200,262	$ 188,231	$ 175,238	$ 161,205	$ 146,049	$ 129,681	$ 112,004	$ 92,912	$ 72,293	$ 50,024	$ 25,974	$ -	$ -	$ -	$ -	$ 2,258,371	
Principal Requirement		$ -	$ -	$ -	$ -	$ 110,340	$ 119,383	$ 128,933	$ 139,248	$ 150,388	$ 162,419	$ 175,412	$ 189,445	$ 204,601	$ 220,989	$ 238,647	$ 257,738	$ 278,357	$ 300,626	$ 324,676	$ -	$ -	$ -	$ -		$ 3,001,383
Balance Outstanding		$ -	$ -	$ -	$ 3,001,383	$ 2,890,844	$ 2,771,461	$ 2,642,528	$ 2,503,280	$ 2,352,892	$ 2,190,473	$ 2,015,060	$ 1,825,615	$ 1,621,014	$ 1,400,045	$ 1,161,398	$ 903,660	$ 625,302	$ 324,676	$ 0	$ 0	$ 0	$ 0	$ 0		
ADB Debt Service Requirements - 2013 Projects:																										
Interest Requirement		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 241,966	$ 233,054	$ 223,430	$ 213,036	$ 201,810	$ 189,686	$ 176,592	$ 162,450	$ 147,178	$ 130,683	$ 112,869	$ 93,630	$ 72,851	$ 50,411	$ 26,175	$ 2,275,619	
Principal Requirement		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 111,384	$ 120,305	$ 129,930	$ 140,324	$ 151,550	$ 163,674	$ 176,768	$ 190,909	$ 206,182	$ 222,676	$ 240,491	$ 259,730	$ 280,508	$ 302,949	$ 327,185		$ 3,024,573
Balance Outstanding		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 3,024,573	$ 2,913,180	$ 2,792,874	$ 2,662,945	$ 2,522,621	$ 2,371,071	$ 2,207,397	$ 2,030,630	$ 1,839,720	$ 1,633,539	$ 1,410,862	$ 1,170,372	$ 910,642	$ 630,134	$ 327,185	$ 0		
ADB Debt Service Requirements - 2018 Projects:																										
Interest Requirement		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 108,935	$ 104,923	$ 100,590	$ 95,910	$ 90,856	$ 85,398	$ 79,503	$ 73,136	$ 66,260	$ 108,935	$ 914,445	
Principal Requirement		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 50,150	$ 54,162	$ 58,495	$ 63,175	$ 68,228	$ 73,687	$ 79,582	$ 85,849	$ 92,824	$ 83,896		$ 720,250
Balance Outstanding		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,361,684	$ 1,311,533	$ 1,257,371	$ 1,198,876	$ 1,135,701	$ 1,067,472	$ 993,785	$ 914,203	$ 828,255	$ 735,430	$ 641,434		
ADB Debt Service Requirements - 2028 Projects:																										
Interest Requirement		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	
Principal Requirement		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -		$ -
Balance Outstanding		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 4,094,921	$ 4,094,921	
Exim Debt Service Requirements - 2009 Projects:																										
Interest Requirement		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	
Principal Requirement		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -		$ -
Balance Outstanding		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	
Exim Bank Debt Service Requirements - 2013 Projects:																										
Interest Requirement		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 173,175	$ 143,656	$ 111,776	$ 77,345	$ 40,180	$ -									$ -	$ 548,111	
Principal Requirement		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 368,984	$ 398,503	$ 430,353	$ 464,614	$ 501,899	$ -									$ -		$ 2,164,684
Balance Outstanding		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 2,164,684	$ 1,795,699	$ 1,397,196	$ 966,843	$ 501,899	$ 0	$ 0	$ 0	$ 0	$ 0	$ 0	$ 0	$ 0	$ 0	$ 0	$ 0		
Exim Bank Debt Service Requirements - 2018 Projects:																										
Interest Requirement		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 142,755	$ 118,422	$ 92,141	$ 83,759	$ 33,105	$ -	$ -	$ -	$ -	$ -	$ 450,182	
Principal Requirement		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 304,169	$ 328,502	$ 354,703	$ 383,165	$ 413,818	$ -	$ -	$ -	$ -	$ -		$ 1,784,438
Balance Outstanding		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,784,438	$ 1,480,269	$ 1,151,766	$ 798,984	$ 415,818	$ 0	$ 0	$ 0	$ 0	$ 0	$ 0		
Exim Bank Debt Service Requirements - 2028 Projects:																										
Interest Requirement		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	
Principal Requirement		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -		$ -
Balance Outstanding		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
																									$ 10,539,850	$ 10,685,328

Source: AAROTEC Infrastructure Group, Inc.

Table 11-2

Nacala Operating Revenue Projections

Operating Revenues:	Forecast Factors	Actual 2006	Forecast 2007	Forecast 2008	Forecast 2009	Forecast 2010	Forecast 2011	Forecast 2012	Forecast 2013	Forecast 2014	Forecast 2015	Forecast 2016	Forecast 2017	Forecast 2018	Forecast 2019	Forecast 2020	Forecast 2021	Forecast 2022	Forecast 2023	Forecast 2024	Forecast 2025	Forecast 2026	Forecast 2027	Forecast 2028	Average Annual Growth Rate (%)
Aeronautical Revenues:																									
Landing Charges (Enhanced)	Aircraft Operations & Inflation	$ -	$ -	$ -	$ -	$ 85,854	$ 166,712	$ 182,564	$ 199,589	$ 214,966	$ 271,326	$ 291,949	$ 314,284	$ 338,471	$ 381,732	$ 557,297	$ 598,317	$ 635,383	$ 683,744	$ 732,684	$ 921,732	$ 989,091	$ 1,061,730	$ 1,140,377	17.17%
Parking Charges (Enhanced)	Aircraft Operations & Inflation	$ -	$ -	$ -	$ -	$ 8,103	$ 39,384	$ 43,200	$ 47,222	$ 50,788	$ 64,098	$ 68,970	$ 74,249	$ 79,961	$ 85,456	$ 252,763	$ 270,432	$ 289,554	$ 310,138	$ 332,341	$ 418,088	$ 448,640	$ 481,538	$ 517,261	25.97%
Passenger Charges (Enhanced)	Enplaned Passengers & Inflation	$ -	$ -	$ -	$ -	$ 303,859	$ 524,680	$ 584,568	$ 768,923	$ 838,752	$ 1,125,886	$ 1,218,708	$ 1,320,449	$ 1,690,093	$ 1,822,841	$ 2,308,742	$ 2,494,023	$ 2,696,373	$ 3,296,141	$ 3,569,487	$ 4,539,648	$ 4,924,572	$ 5,346,821	$ 5,810,444	17.81%
Cargo Charges	Cargo & Mail Weight & Inflation	$ -	$ -	$ -	$ -	$ 12,012	$ 12,282	$ 13,380	$ 14,477	$ 15,560	$ 19,545	$ 20,832	$ 22,103	$ 23,390	$ 24,673	$ 30,448	$ 31,959	$ 33,469	$ 34,372	$ 36,471	$ 42,795	$ 42,795	$ 42,795	$ 42,795	7.31%
Air Navigation Charges	Aircraft Operations & Inflation	$ -	$ -	$ -	$ -	$ 27,618	$ 56,947	$ 62,465	$ 68,280	$ 73,437	$ 92,683	$ 98,727	$ 107,360	$ 115,619	$ 123,564	$ 155,048	$ 165,904	$ 177,602	$ 190,227	$ 203,846	$ 256,439	$ 275,176	$ 295,358	$ 317,269	14.53%
Fuel Charges	Aircraft Operations, Rates & Inflation	$ -	$ -	$ -	$ -	$ 3,324	$ 16,769	$ 44,377	$ 47,261	$ 50,333	$ 53,605	$ 57,089	$ 60,800	$ 64,752	$ 68,961	$ 73,444	$ 78,217	$ 83,302	$ 88,716	$ 94,483	$ 100,624	$ 107,165	$ 114,130	$ 121,549	22.13%
Lighting Charges (New)	Aircraft Operations & Inflation	$ -	$ -	$ -	$ -	$ -	$ 189,329	$ 207,673	$ 227,006	$ 244,153	$ 262,601	$ 282,561	$ 304,188	$ 327,587	$ 350,101	$ 748,770	$ 801,197	$ 857,688	$ 918,681	$ 984,429	$ 1,055,405	$ 1,132,536	$ 1,215,710	$ 1,305,762	12.03%
Security Charges (New)	Enplaned Passengers & Inflation	$ -	$ -	$ -	$ -		$ 71,878	$ 80,068	$ 82,923	$ 95,880	$ 103,726	$ 112,300	$ 121,675	$ 132,022	$ 142,391	$ 307,393	$ 332,062	$ 359,004	$ 388,450	$ 420,684	$ 455,938	$ 494,597	$ 537,006	$ 583,570	13.11%
Non-Aeronautical Revenues:																									
Rental Charges	Terminal Space, Rates & Inflation	$ -	$ -	$ -	$ -	$ 249,326	$ 591,436	$ 591,436	$ 814,536	$ 814,536	$ 955,776	$ 955,776	$ 955,776	$ 1,178,876	$ 1,178,876	$ 1,383,293	$ 1,383,293	$ 1,383,293	$ 1,606,393	$ 1,606,393	$ 1,884,942	$ 1,884,942	$ 1,884,942	$ 3,769,884	16.29%
Usage Charges	Enplaned Passengers, Rates & Inflation	$ -	$ -	$ -	$ -	$ 104,266	$ 178,970	$ 197,178	$ 365,808	$ 422,964	$ 536,921	$ 581,300	$ 628,529	$ 840,742	$ 1,014,633	$ 1,255,098	$ 1,388,227	$ 1,500,859	$ 2,002,589	$ 2,168,840	$ 2,758,081	$ 2,891,922	$ 3,248,458	$ 3,530,133	21.61%
Miscellaneous Charges	Inflation	$ -	$ -	$ -	$ -	$ 17,337	$ 18,484	$ 19,664	$ 20,942	$ 22,304	$ 23,753	$ 25,297	$ 26,942	$ 28,683	$ 30,558	$ 32,544	$ 34,690	$ 36,913	$ 39,312	$ 41,867	$ 44,588	$ 47,487	$ 50,573	$ 53,861	6.50%
Total Operating Revenues		$ -	$ -	$ -	$ -	$ 791,699	$ 1,864,852	$ 2,026,890	$ 2,655,269	$ 2,891,693	$ 3,509,701	$ 3,714,510	$ 3,937,666	$ 4,920,206	$ 5,203,791	$ 7,134,860	$ 7,576,342	$ 8,056,419	$ 9,558,723	$ 10,191,314	$ 12,478,262	$ 13,338,926	$ 14,279,143	$ 17,192,904	16.65%
Total Operating Revenues/Enplaned Passengers		$ -	$ -	$ -	$ -	$ 23.98	$ 33.27	$ 32.46	$ 41.07	$ 38.68	$ 43.39	$ 42.42	$ 41.50	$ 47.80	$ 46.87	$ 59.54	$ 58.52	$ 57.56	$ 63.12	$ 62.14	$ 70.20	$ 69.16	$ 68.20	$ 75.57	6.59%
Total Passenger Charges/Enplaned Passengers		$ -	$ -	$ -	$ -	$ 9.20	$ 9.36	$ 9.36	$ 11.88	$ 11.86	$ 13.92	$ 13.92	$ 13.92	$ 16.42	$ 16.42	$ 19.26	$ 19.26	$ 19.26	$ 21.78	$ 21.78	$ 25.54	$ 25.54	$ 25.54	$ 25.54	5.83%
Total Usage Charges/Enplaned Passengers		$ -	$ -	$ -	$ -	$ 3.16	$ 3.16	$ 3.16	$ 5.66	$ 5.66	$ 6.64	$ 6.94	$ 6.84	$ 9.14	$ 9.14	$ 10.72	$ 10.72	$ 10.72	$ 13.22	$ 13.22	$ 15.52	$ 15.52	$ 15.52	$ 15.52	9.25%
Total Rental Charges/Rentable Space		$ -	$ -	$ -	$ -	$ 132.55	$ 132.55	$ 132.55	$ 182.55	$ 182.55	$ 214.20	$ 214.20	$ 214.20	$ 264.20	$ 264.20	$ 310.02	$ 310.02	$ 310.02	$ 360.02	$ 360.02	$ 422.44	$ 422.44	$ 422.44	$ 422.44	6.65%
Above - US$/Square Foot Equivalent	10.7584	$ -	$ -	$ -	$ -	$ 12.32	$ 12.32	$ 12.32	$ 16.97	$ 16.97	$ 19.91	$ 19.91	$ 19.91	$ 24.56	$ 24.56	$ 28.82	$ 28.82	$ 28.82	$ 33.46	$ 33.46	$ 39.27	$ 39.27	$ 39.27	$ 39.27	6.65%

Source: ARROTEC Infrastructure Group, Inc.

Table 11-3
Nacala Operating Expense Projections

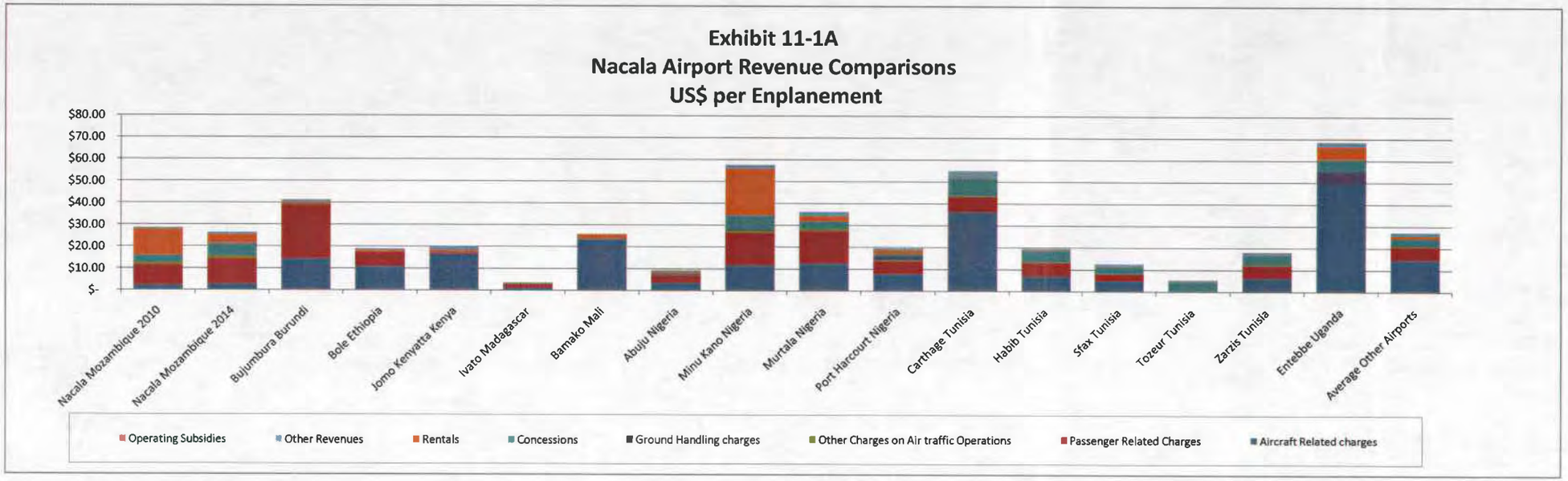
Operating Expenses:	Forcast Factors	Actual 2006	Forecast 2007	Forecast 2008	Forecast 2009	Forecast 2010	Forecast 2011	Forecast 2012	Forecast 2013	Forecast 2014	Forecast 2015	Forecast 2016	Forecast 2017	Forecast 2018	Forecast 2019	Forecast 2020	Forecast 2021	Forecast 2022	Forecast 2023	Forecast 2024	Forecast 2025	Forecast 2026	Forecast 2027	Forecast 2028	Average Annual Growth Rate (%)
Personnel Costs	Employees & Inflation	$ -	$ -	$ -	$ -	$ 763,517	$ 834,765	$ 869,024	$ 946,611	$ 1,008,354	$ 1,073,897	$ 1,143,700	$ 1,216,040	$ 1,297,213	$ 1,381,532	$ 1,471,331	$ 1,568,968	$ 1,668,821	$ 1,777,294	$ 1,892,815	$ 2,015,852	$ 2,146,882	$ 2,286,429	$ 2,435,047	6.50%
Supply Costs	Operations & Inflation	$ -	$ -	$ -	$ -	$ 19,288	$ 42,342	$ 49,484	$ 57,583	$ 65,868	$ 75,553	$ 86,579	$ 99,265	$ 113,849	$ 129,542	$ 147,578	$ 168,175	$ 191,734	$ 218,714	$ 249,606	$ 284,987	$ 325,703	$ 372,346	$ 425,924	18.78%
Contract Service Costs	Operations & Inflation	$ -	$ -	$ -	$ -	$ 6,382	$ 18,408	$ 21,502	$ 25,032	$ 28,672	$ 32,843	$ 37,837	$ 43,151	$ 49,491	$ 56,330	$ 64,153	$ 73,107	$ 83,348	$ 95,076	$ 108,505	$ 123,890	$ 141,585	$ 161,862	$ 185,152	18.76%
Finance Costs	Inflation	$ -	$ -	$ -	$ -	$ 1,147	$ 1,221	$ 1,301	$ 1,385	$ 1,475	$ 1,571	$ 1,673	$ 1,782	$ 1,898	$ 2,021	$ 2,152	$ 2,292	$ 2,441	$ 2,600	$ 2,769	$ 2,949	$ 3,141	$ 3,345	$ 3,562	6.50%
Administrative Fee Costs	Operating Revenues	$ -	$ -	$ -	$ -	$ 7,917	$ 16,649	$ 20,269	$ 26,553	$ 28,917	$ 35,097	$ 37,145	$ 39,377	$ 49,202	$ 52,038	$ 71,349	$ 75,763	$ 80,564	$ 95,587	$ 101,913	$ 124,783	$ 133,389	$ 142,791	$ 171,929	16.65%
Total Operating Expenses		$ -	$ -	$ -	$ -	$ 820,545	$ 915,383	$ 961,580	$ 1,057,364	$ 1,133,376	$ 1,218,961	$ 1,306,734	$ 1,401,615	$ 1,511,653	$ 1,621,503	$ 1,756,563	$ 1,886,305	$ 2,026,909	$ 2,189,271	$ 2,355,611	$ 2,552,470	$ 2,750,700	$ 2,966,775	$ 3,221,615	7.89%
Total Operating Expenses/Enplaned Passengers		$ -	$ -	$ -	$ -	$ 24.85	$ 16.33	$ 15.72	$ 16.35	$ 15.16	$ 15.07	$ 14.92	$ 14.77	$ 14.68	$ 14.60	$ 14.66	$ 14.57	$ 14.43	$ 14.46	$ 14.36	$ 14.38	$ 14.27	$ 14.17	$ 14.16	-3.08%

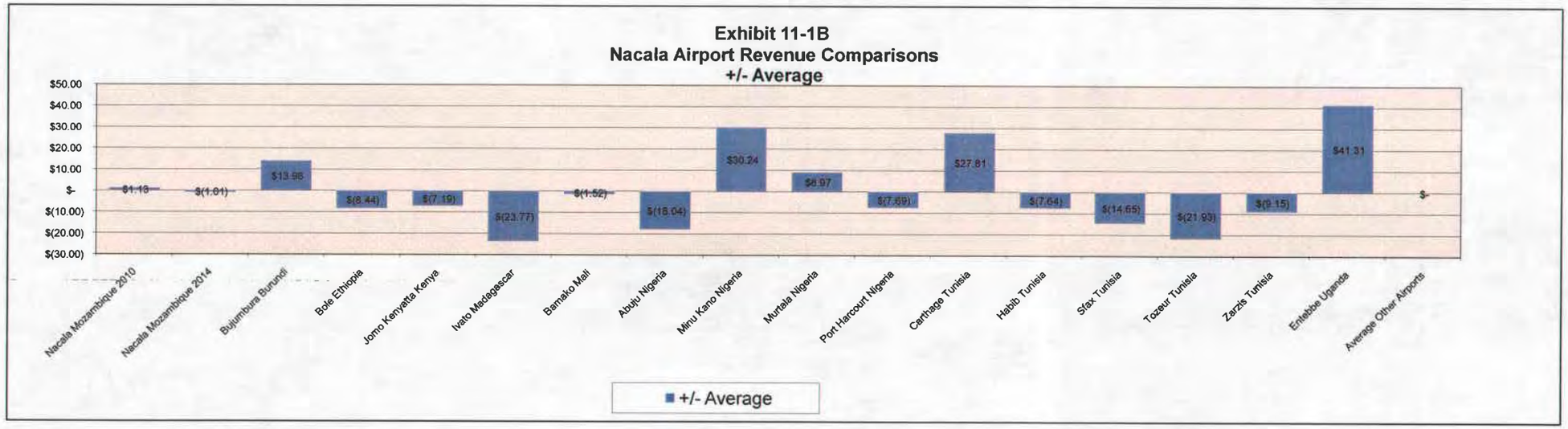
Source: ARROTEC Infrastructure Group, Inc.

Table 11-4
Nacala Cash Flow Projections

Cash Flow:	Actual 2006	Forecast 2007	Forecast 2008	Forecast 2009	Forecast 2010	Forecast 2011	Forecast 2012	Forecast 2013	Forecast 2014	Forecast 2015	Forecast 2016	Forecast 2017	Forecast 2018	Forecast 2019	Forecast 2020	Forecast 2021	Forecast 2022	Forecast 2023	Forecast 2024	Forecast 2025	Forecast 2026	Forecast 2027	Forecast 2028	Total 2006-2028
From Operations:																								
Operating Revenues	$ -	$ -	$ -	$ -	$ 791,699	$ 1,864,852	$ 2,026,890	$ 2,655,269	$ 2,891,693	$ 3,509,701	$ 3,714,510	$ 3,937,666	$ 4,920,206	$ 5,203,791	$ 7,134,860	$ 7,576,342	$ 8,056,419	$ 9,558,723	$ 10,191,314	$ 12,478,262	$ 13,338,926	$ 14,279,143	$ 17,192,904	$ 131,323,171
Less: Operating Expenses	$ -	$ -	$ -	$ -	$ (820,545)	$ (915,383)	$ (961,580)	$ (1,057,364)	$ (1,133,376)	$ (1,218,961)	$ (1,306,734)	$ (1,401,615)	$ (1,511,653)	$ (1,621,503)	$ (1,756,563)	$ (1,886,305)	$ (2,026,909)	$ (2,189,271)	$ (2,355,611)	$ (2,552,470)	$ (2,750,700)	$ (2,966,775)	$ (3,221,615)	$ (33,674,912)
From Development:																								
Less: Existing Debt Service - Principal	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Less: New ADM Equity Requirement - 2009 Construction Requirements	$ -	$ -	$ -	$ (3,849,832)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ (3,849,832)
Less: New ADB Interest Requirement - 2009 Construction Requirements	$ -	$ -	$ -	$ -	$ (240,111)	$ (231,268)	$ (221,717)	$ (211,402)	$ (200,282)	$ (188,231)	$ (175,238)	$ (161,205)	$ (146,049)	$ (129,681)	$ (112,004)	$ (92,912)	$ (72,293)	$ (50,024)	$ (25,974)	$ -	$ -	$ -	$ -	$ (2,258,371)
Less: New ADB Principal Requirement - 2009 Constructions Requirements	$ -	$ -	$ -	$ -	$ (110,540)	$ (118,383)	$ (126,933)	$ (139,248)	$ (150,368)	$ (162,419)	$ (175,412)	$ (189,445)	$ (204,601)	$ (220,969)	$ (238,647)	$ (257,738)	$ (278,357)	$ (300,626)	$ (324,676)	$ -	$ -	$ -	$ -	$ (3,001,363)
Less: New ADM Equity Requirement - 2013 Construction Requirements	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ (4,580,131)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ (4,580,131)
Less: New ADB Interest Requirement - 2013 construction Requirements	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ (241,966)	$ (233,054)	$ (223,430)	$ (213,036)	$ (201,810)	$ (189,686)	$ (176,592)	$ (162,450)	$ (147,175)	$ (130,683)	$ (112,869)	$ (93,630)	$ (72,851)	$ (50,411)	$ (26,175)	$ (2,273,819)
Less: New ADB Principal Requirement - 2013 Constructions Requirements	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ (111,394)	$ (120,305)	$ (129,930)	$ (140,324)	$ (151,550)	$ (163,674)	$ (176,768)	$ (190,909)	$ (206,182)	$ (222,676)	$ (240,491)	$ (259,730)	$ (280,508)	$ (302,949)	$ (327,185)	$ (3,024,573)
Less: New ADM Equity Requirement - 2018 Construction Projects	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ (1,571,733)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ (1,571,733)
Less: New ADB Interest Requirement - 2018 Construction Requirements	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ (108,935)	$ (104,823)	$ (100,580)	$ (95,910)	$ (90,656)	$ (85,398)	$ (79,503)	$ (73,136)	$ (66,260)	$ (108,935)	$ (814,445)
Less: New ADB Principal Requirement - 2018 Construction Requirements	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ (50,150)	$ (54,182)	$ (58,495)	$ (63,175)	$ (68,228)	$ (73,687)	$ (79,552)	$ (85,949)	$ (92,824)	$ (93,998)	$ (720,250)
Less: New ADM Equity Requirement - 2023 Constructions Requirements	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ (14,545,170)	$ (14,545,170)
Less: New ADB Interest Requirement - 2023 Construction Requirements	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Less: New ADB Principal Requirement - 2023 Construction Requirements	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Less: New ADM Equity Requirement - 2009 Import Requirements	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Less: New Exim Bank Interest Requirement - 2009 Import Requirements	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Less: New Exim Bank Principal Requirement - 2009 Import Requirements	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Less: New ADM Equity Requirement - 2013 Import Requirements	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ (480,641)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ (480,641)
Less: New Exim Bank Interest Requirement - 2013 Import Requirements	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ (173,175)	$ (143,658)	$ (111,776)	$ (77,345)	$ (40,160)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ (546,111)
Less: New Exim Bank Principal Requirement - 2013 Import Requirements	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ (368,984)	$ (398,503)	$ (430,363)	$ (464,814)	$ (501,999)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ (2,164,664)
Less: New ADM Equity Requirement - 2018 Import Requirements	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ (479,796)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ (479,796)
Less: New Exim Bank Interest Requirement - 2018 Import Requirements	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ (142,755)	$ (118,422)	$ (92,141)	$ (63,759)	$ (33,105)	$ -	$ -	$ -	$ -	$ -	$ (450,182)
Less: New Exim Bank Principal Requirement - 2018 Import Requirements	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ (304,169)	$ (328,502)	$ (354,783)	$ (383,165)	$ (413,818)	$ -	$ -	$ -	$ -	$ -	$ (1,784,436)
Less: New ADM Equity Requirement - 2028 Import Requirements	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Less: New Exim Bank Interest Requirement - 2028 Import Requirements	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Less: New Exim Bank Principal Requirement - 2028 Import Requirements	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Net Cash Flow	$ -	$ -	$ -	$ (3,849,832)	$ (379,496)	$ 598,819	$ 694,680	$ (3,813,517)	$ 512,149	$ 1,044,571	$ 1,181,607	$ 1,239,853	$ 110,855	$ 2,272,270	$ 4,068,278	$ 4,380,016	$ 4,719,491	$ 6,059,433	$ 8,972,808	$ 9,413,347	$ 10,075,782	$ 10,798,923	$ (1,130,172)	$ 55,000,695

Weighted Average Cost of Capital (WAAC)	13.81%
Net Present Value (NPV)	$4,264,412
Internal Rate of Return (IRR)	20.24%





Source: AAROTEC for Nacala data and ICAO for regional data

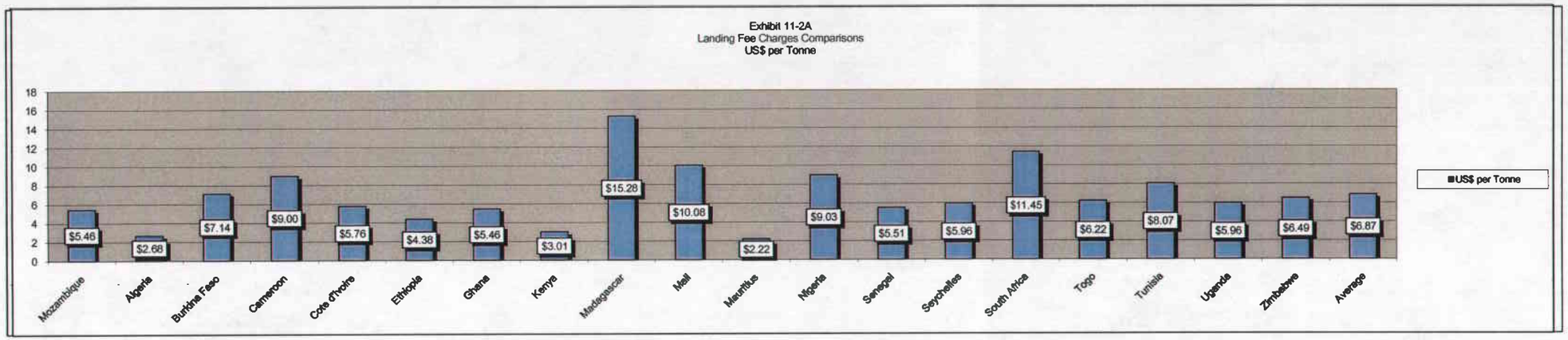


Exhibit 11-2A
Landing Fee Charges Comparisons
US$ per Tonne
18
16
14
12
10
8
6
4
2
0
$5.46
$2.68
$7.14
$9.00
$5.76
$4.38
$5.46
$3.01
$15.28
$10.08
$2.22
$9.03
$5.51
$5.96
$11.45
$6.22
$8.07
$5.96
$6.49
$6.87
Mozambique
Algeria
Burkina Faso
Cameroon
Cote d'Ivoire
Ethiopia
Ghana
Kenya
Madagascar
Mali
Mauritius
Nigeria
Senegal
Seychelles
South Africa
Togo
Tunisia
Uganda
Zimbabwe
Average
US$ per Tonne

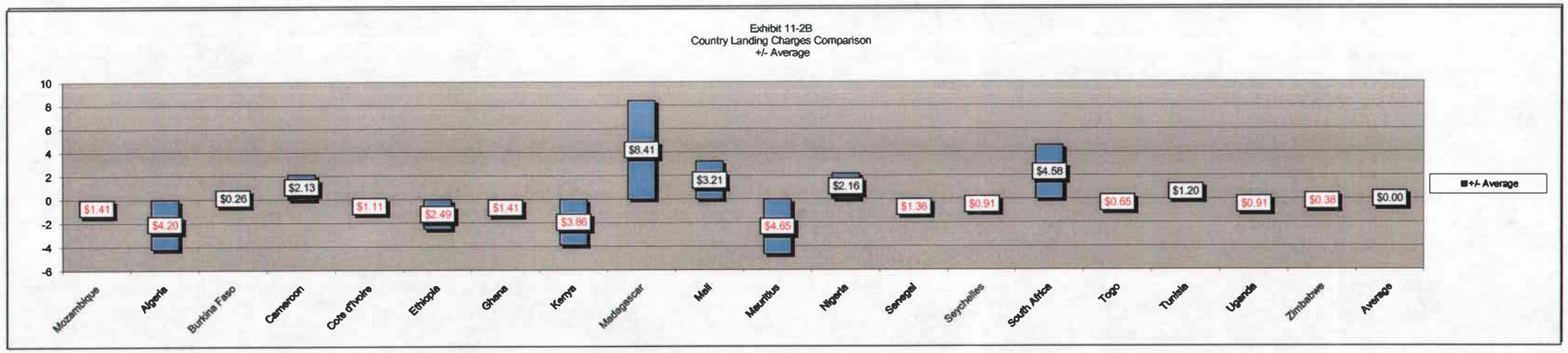


Exhibit 11-2B
Country Landing Charges Comparison
+/- Average
10
8
6
4
2
0
-2
-4
-6
$1.41
$4.20
$0.26
$2.13
$1.11
$2.49
$1.41
$3.86
$8.41
$3.21
$4.65
$2.16
$1.36
$0.91
$4.58
$0.65
$1.20
$0.91
$0.38
$0.00
Mozambique
Algeria
Burkina Faso
Cameroon
Cote d'Ivoire
Ethiopia
Ghana
Kenya
Madagascar
Mali
Mauritius
Nigeria
Senegal
Seychelles
South Africa
Togo
Tunisia
Uganda
Zimbabwe
Average
+/- Average

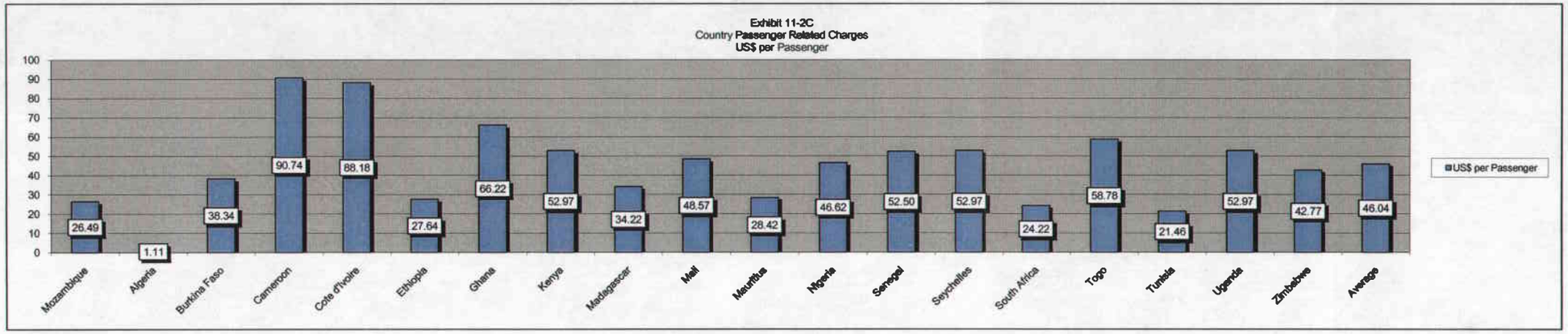


Exhibit 11-2C
Country Passenger Related Charges
US$ per Passenger
100
90
80
70
60
50
40
30
20
10
0
26.49
1.11
38.34
90.74
88.18
27.64
66.22
52.97
34.22
48.57
28.42
46.62
52.50
52.97
24.22
58.78
21.46
52.97
42.77
46.04
Mozambique
Algeria
Burkina Faso
Cameroon
Cote d'Ivoire
Ethiopia
Ghana
Kenya
Madagascar
Mali
Mauritius
Nigeria
Senegal
Seychelles
South Africa
Togo
Tunisia
Uganda
Zimbabwe
Average
US$ per Passenger

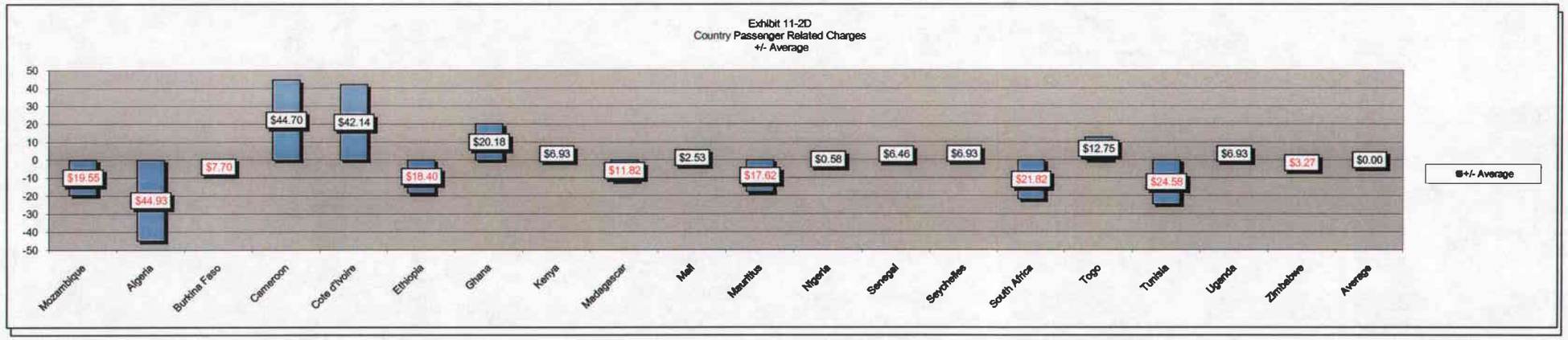


Exhibit 11-2D
Country Passenger Related Charges
+/- Average
50
40
30
20
10
0
-10
-20
-30
-40
-50
$19.55
$44.93
$7.70
$44.70
$42.14
$18.40
$20.18
$6.93
$11.82
$2.53
$17.62
$0.58
$6.46
$6.93
$21.82
$12.75
$24.58
$6.93
$3.27
$0.00
Mozambique
Algeria
Burkina Faso
Cameroon
Cote d'Ivoire
Ethiopia
Ghana
Kenya
Madagascar
Mali
Mauritius
Nigeria
Senegal
Seychelles
South Africa
Togo
Tunisia
Uganda
Zimbabwe
Average
+/- Average

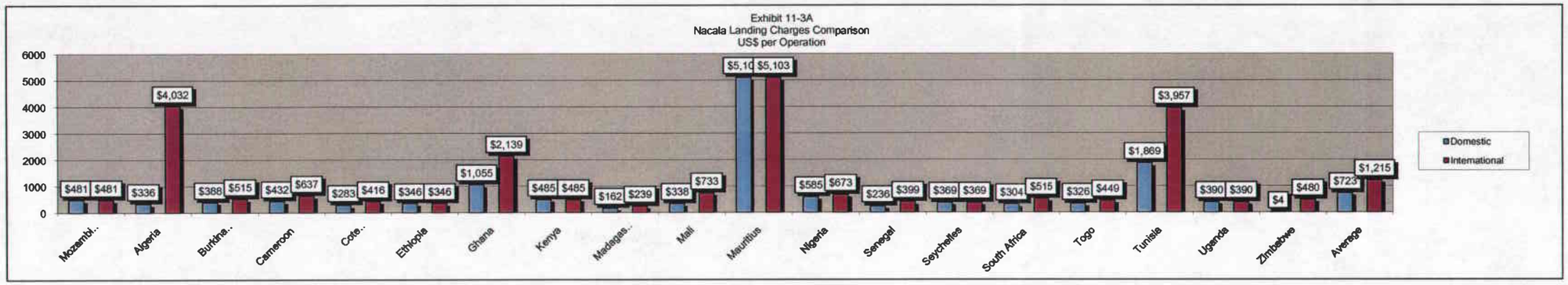


Exhibit 11-3A
Nacala Landing Charges Comparison
US$ per Operation
6000
5000
4000
3000
2000
1000
0
$481 $481
$336 $4,032
$388 $515
$432 $637
$283 $416
$346 $346
$1,055 $2,139
$485 $485
$162 $239
$338 $733
$5,10 $5,103
$585 $673
$236 $399
$369 $369
$304 $515
$326 $449
$1,869 $3,957
$390 $390
$4 $480
$723 $1,215
Mozambi..
Algeria
Burkina..
Cameroon
Cote..
Ethiopia
Ghana
Kenya
Madagas..
Mali
Mauritius
Nigeria
Senegal
Seychelles
South Africa
Togo
Tunisia
Uganda
Zimbabwe
Average
Domestic
International

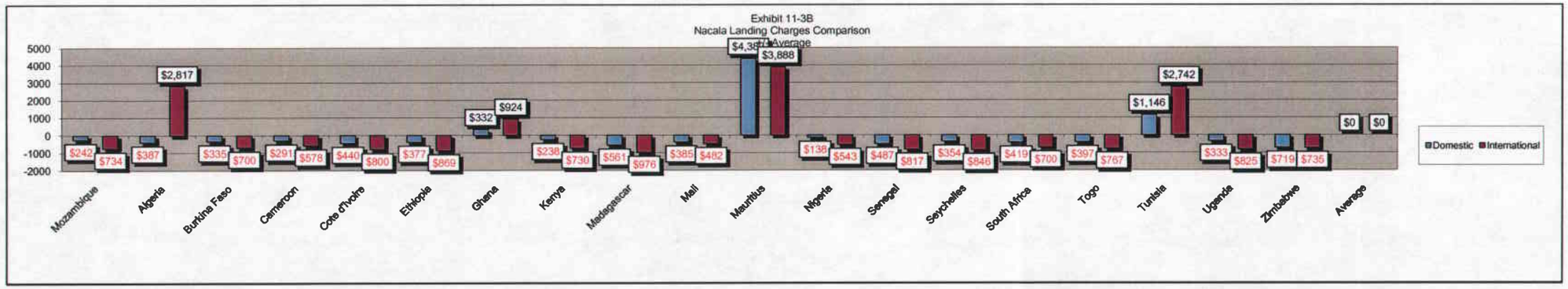
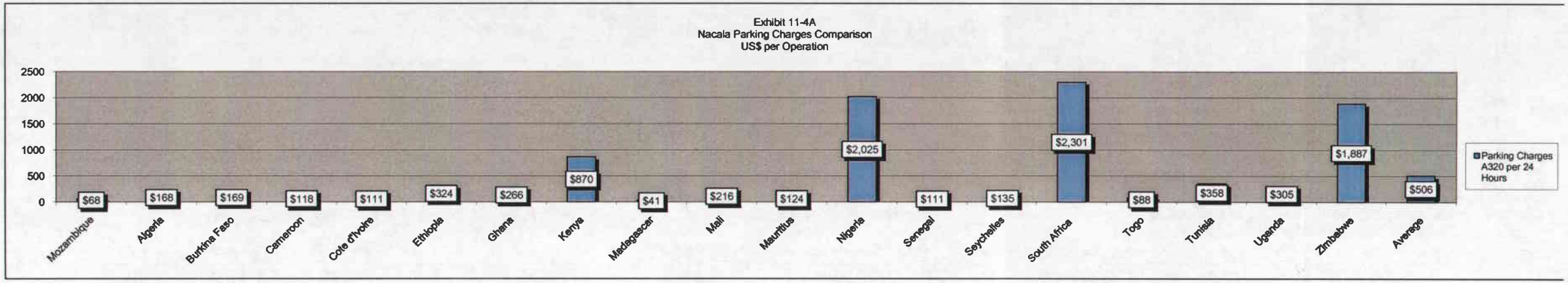
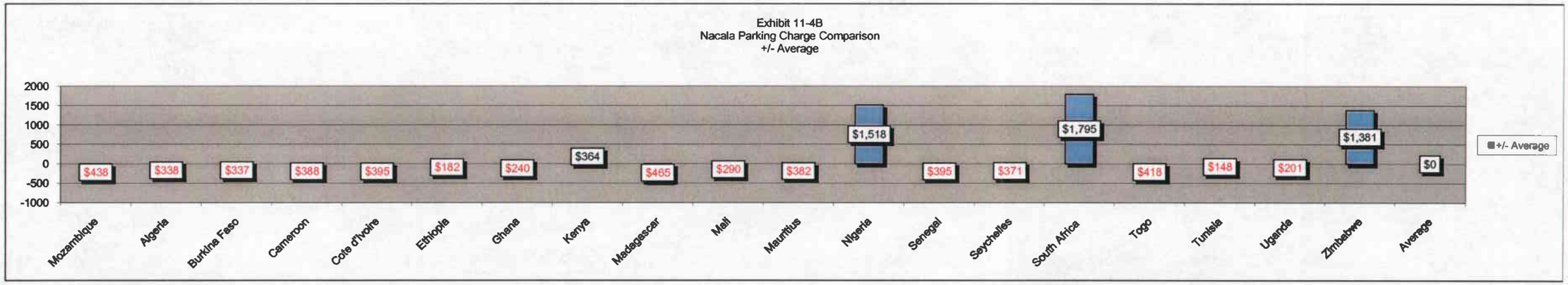


Exhibit 11-3B
Nacala Landing Charges Comparison
5000
4000
3000
2000
1000
0
-1000
-2000
$242 $734
$387 $2,817
$335 $700
$291 $578
$440 $800
$377 $869
$332 $924
$238 $730
$561 $976
$385 $482
$3,888
$138 $543
$487 $817
$354 $846
$419 $700
$397 $767
$1,146 $2,742
$333 $825
$719 $735
$0 $0
Mozambique
Algeria
Burkina Faso
Cameroon
Cote d'Ivoire
Ethiopia
Ghana
Kenya
Madagascar
Mali
Mauritius
Nigeria
Senegal
Seychelles
South Africa
Togo
Tunisia
Uganda
Zimbabwe
Average
Domestic
International





Source: International Civil Aviation Organization

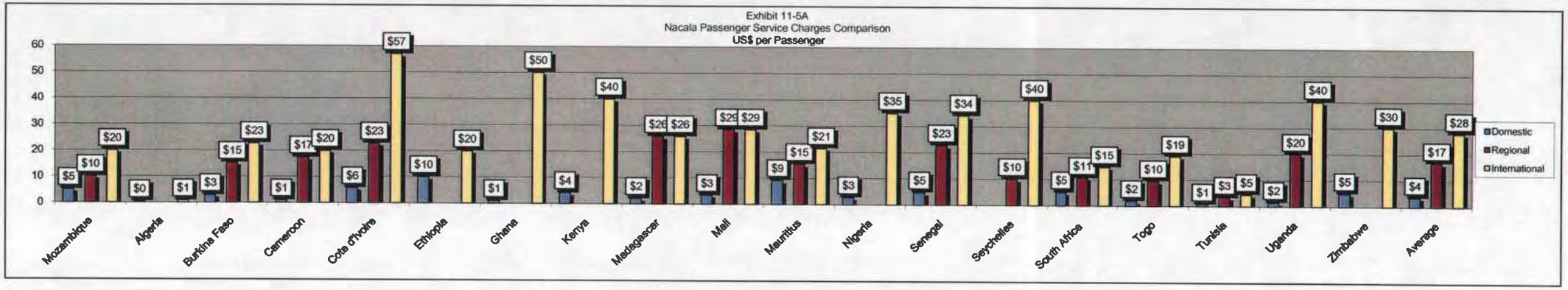


Exhibit 11-5A
Nacala Passenger Service Charges Comparison
US$ per Passenger
60
50
40
30
20
10
0
Mozambique
Algeria
Burkina Faso
Cameroon
Cote d'Ivoire
Ethiopia
Ghana
Kenya
Madagascar
Mali
Mauritius
Nigeria
Senegal
Seychelles
South Africa
Togo
Tunisia
Uganda
Zimbabwe
Average
Domestic
Regional
International

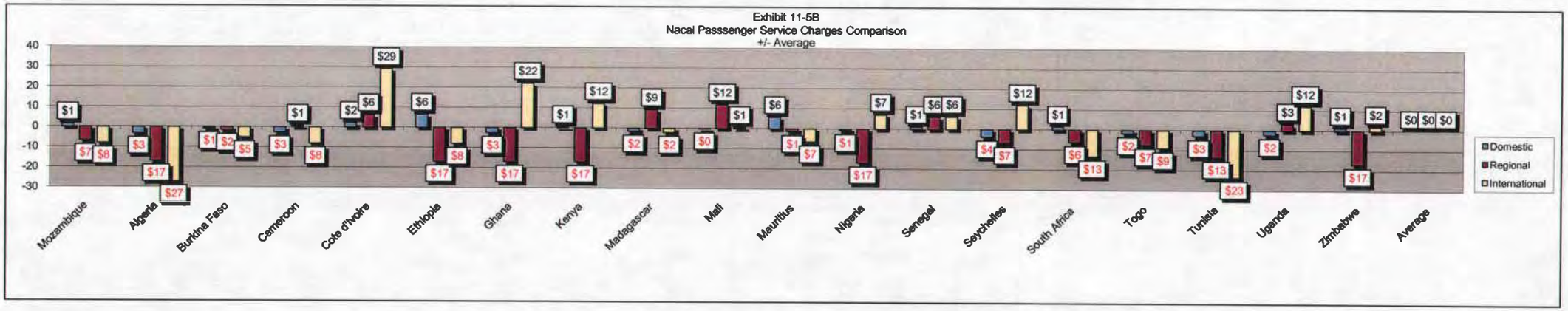


Exhibit 11-5B
Nacal Passsenger Service Charges Comparison
+/- Average
40
30
20
10
0
-10
-20
-30
Mozambique
Algeria
Burkina Faso
Cameroon
Cote d'Ivoire
Ethiopia
Ghana
Kenya
Madagascar
Mali
Mauritius
Nigeria
Senegal
Seychelles
South Africa
Togo
Tunisia
Uganda
Zimbabwe
Average
Domestic
Regional
International

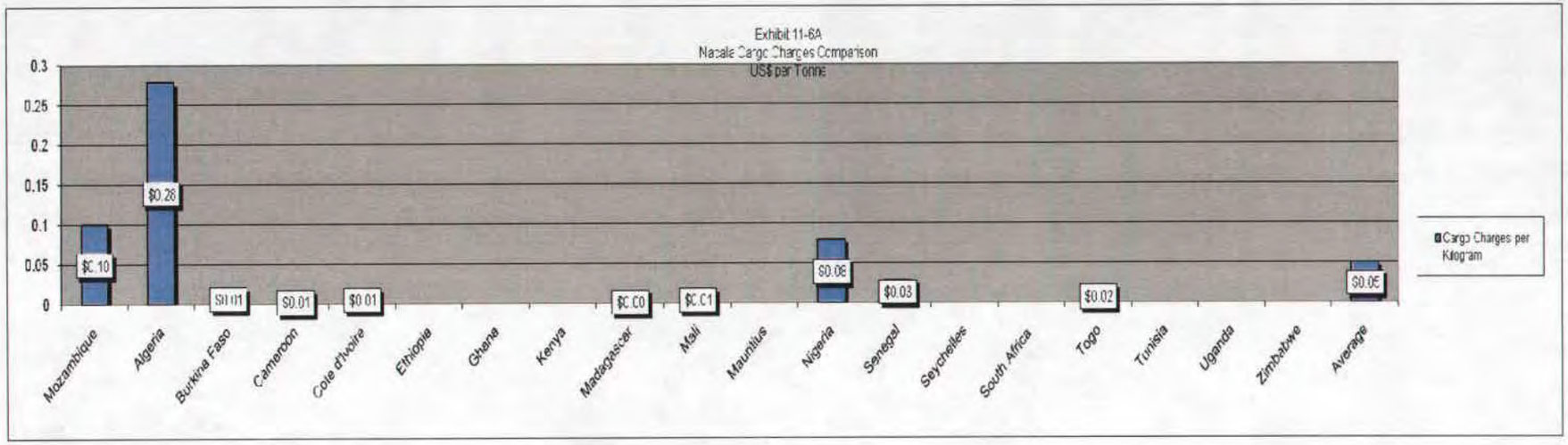


Exhibit 11-6A
Nacala Cargo Charges Comparison
US$ per Tonne
0.3
0.25
0.2
0.15
0.1
0.05
0
$0.10
$0.28
$0.01
$0.01
$0.01
$0.00
$0.01
$0.08
$0.03
$0.02
$0.05
Mozambique
Algeria
Burkina Faso
Cameroon
Cote d'Ivoire
Ethiopia
Ghana
Kenya
Madagascar
Mali
Mauritius
Nigeria
Senegal
Seychelles
South Africa
Togo
Tunisia
Uganda
Zimbabwe
Average
Cargo Charges per Kilogram

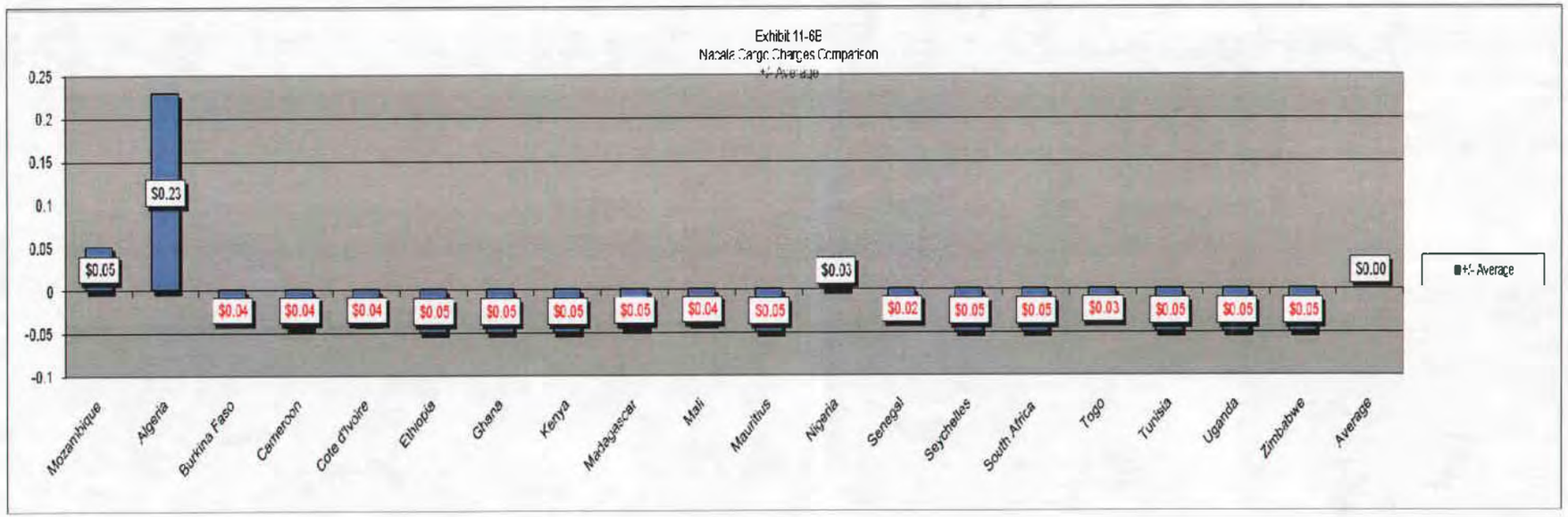


Exhibit 11-6E
Nacala Cargo Charges Comparison
+/- Average
0.25
0.2
0.15
0.1
0.05
0
-0.05
-0.1
$0.05
$0.23
$0.04
$0.04
$0.04
$0.05
$0.05
$0.05
$0.05
$0.04
$0.05
$0.03
$0.02
$0.05
$0.05
$0.03
$0.05
$0.05
$0.05
$0.00
Mozambique
Algeria
Burkina Faso
Cameroon
Cote d'Ivoire
Ethiopia
Ghana
Kenya
Madagascar
Mali
Mauritius
Nigeria
Senegal
Seychelles
South Africa
Togo
Tunisia
Uganda
Zimbabwe
Average
+/- Average

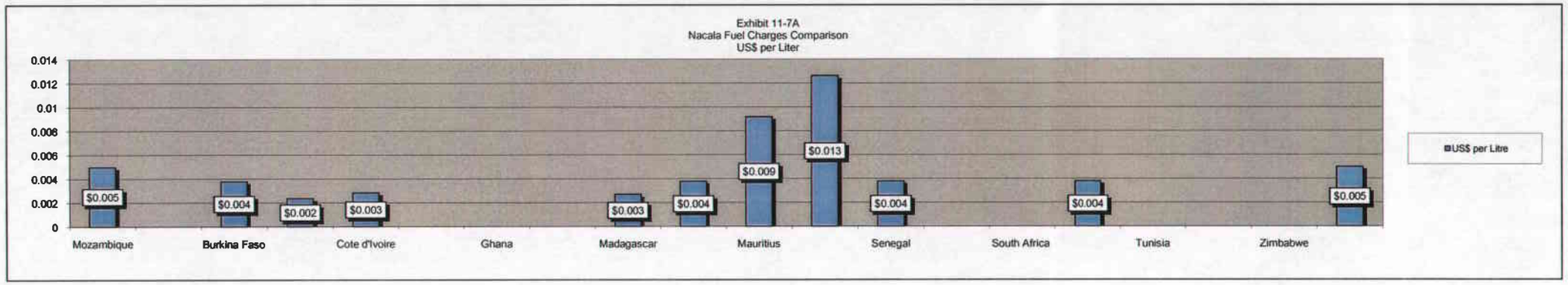


Exhibit 11-7A
Nacala Fuel Charges Comparison
US$ per Liter
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
$0.005
$0.004
$0.002
$0.003
$0.003
$0.004
$0.009
$0.013
$0.004
$0.004
$0.005
Mozambique
Burkina Faso
Cote d'Ivoire
Ghana
Madagascar
Mauritius
Senegal
South Africa
Tunisia
Zimbabwe
US$ per Litre

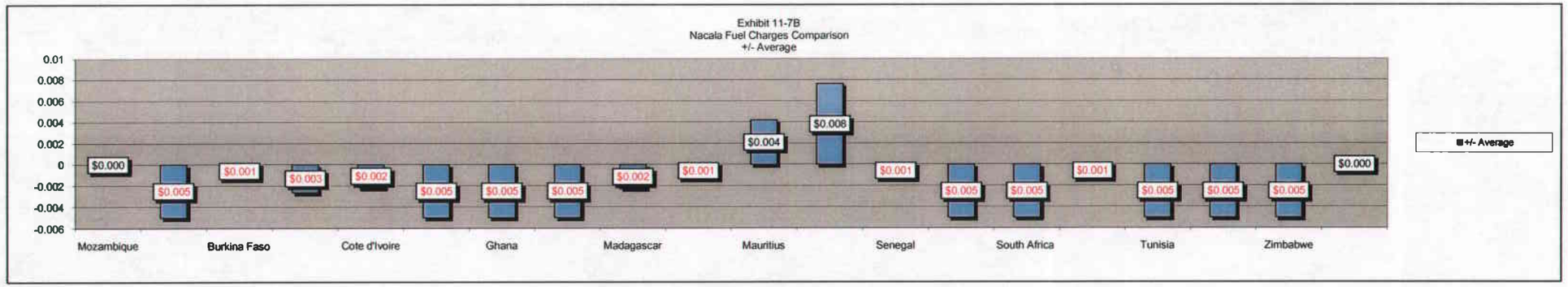


Exhibit 11-7B
Nacala Fuel Charges Comparison
+/- Average
0.01
0.008
0.006
0.004
0.002
0
-0.002
-0.004
-0.006
$0.000
$0.005
$0.001
$0.003
$0.002
$0.005
$0.005
$0.005
$0.002
$0.001
$0.004
$0.006
$0.001
$0.005
$0.005
$0.001
$0.005
$0.005
$0.005
$0.000
Mozambique
Burkina Faso
Cote d'Ivoire
Ghana
Madagascar
Mauritius
Senegal
South Africa
Tunisia
Zimbabwe
+/- Average

Exhibit 11-8A
Nacala Lighting Charges Comparison
US$ per Operation

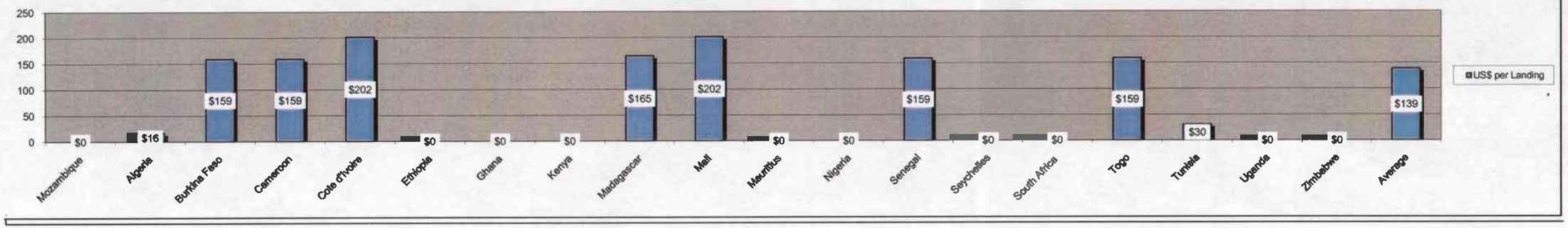
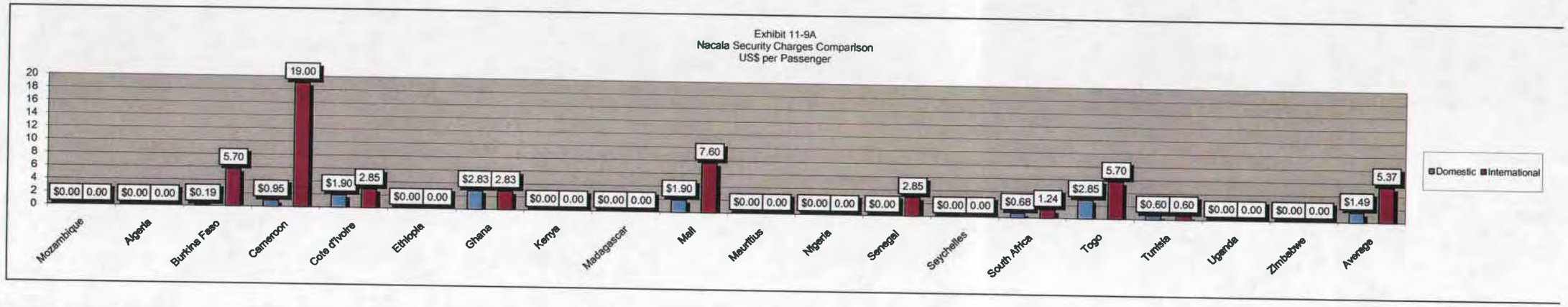
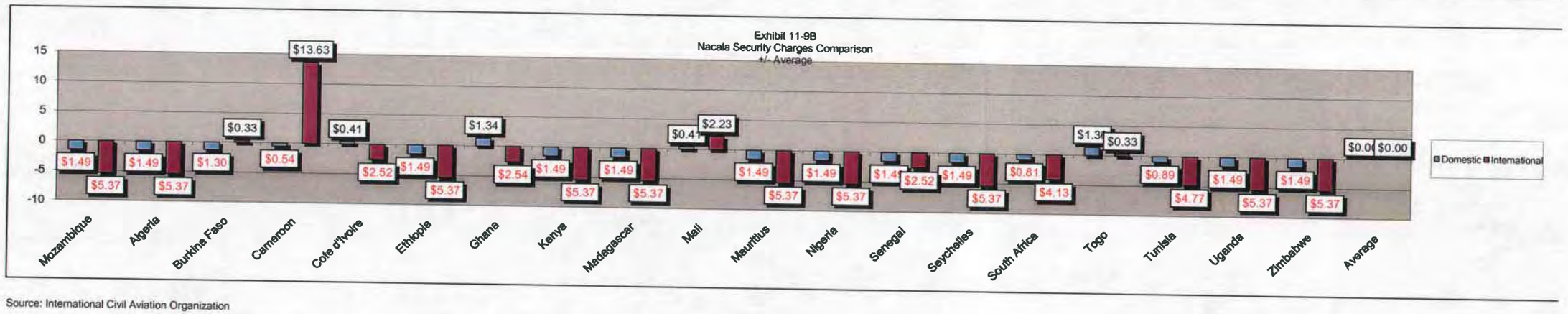


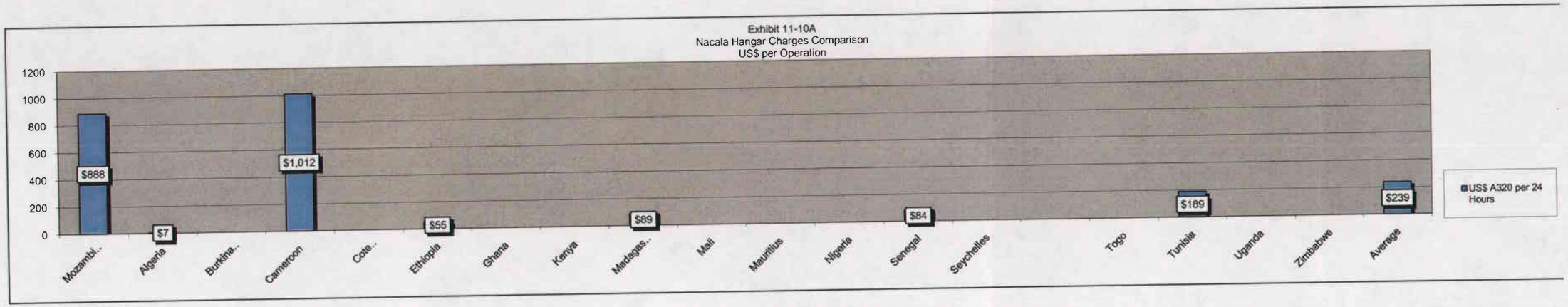
Exhibit 11-8B
Nacal Lighting Charge Comparison
+/- Average

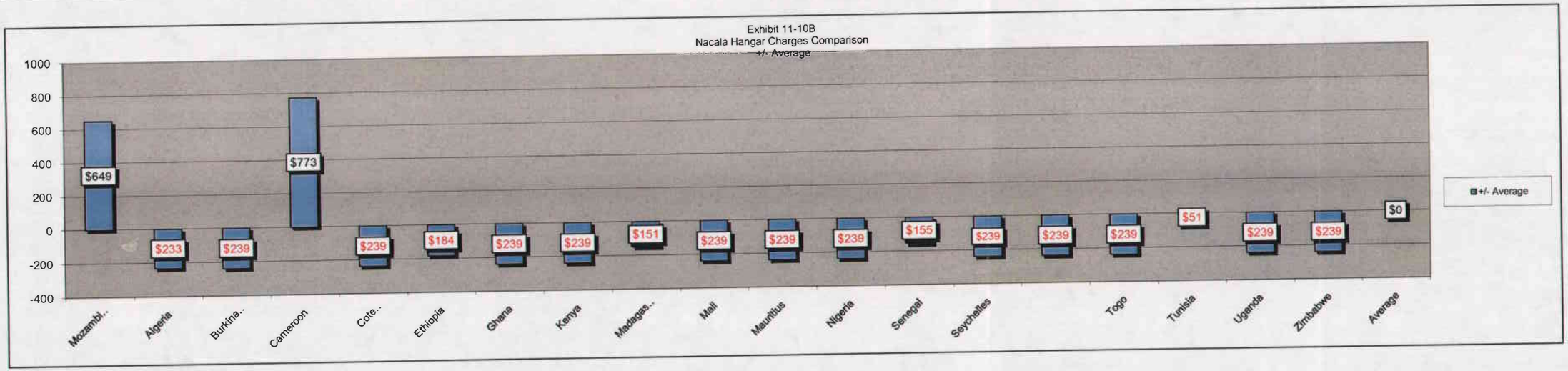
Source: International Civil Aviation Organization





Source: International Civil Aviation Organization





Source: International civil Aviation Organization

Exhibit 11-11A
Nacala Airport
Current Organization Chart (2010)
70 Total Employees

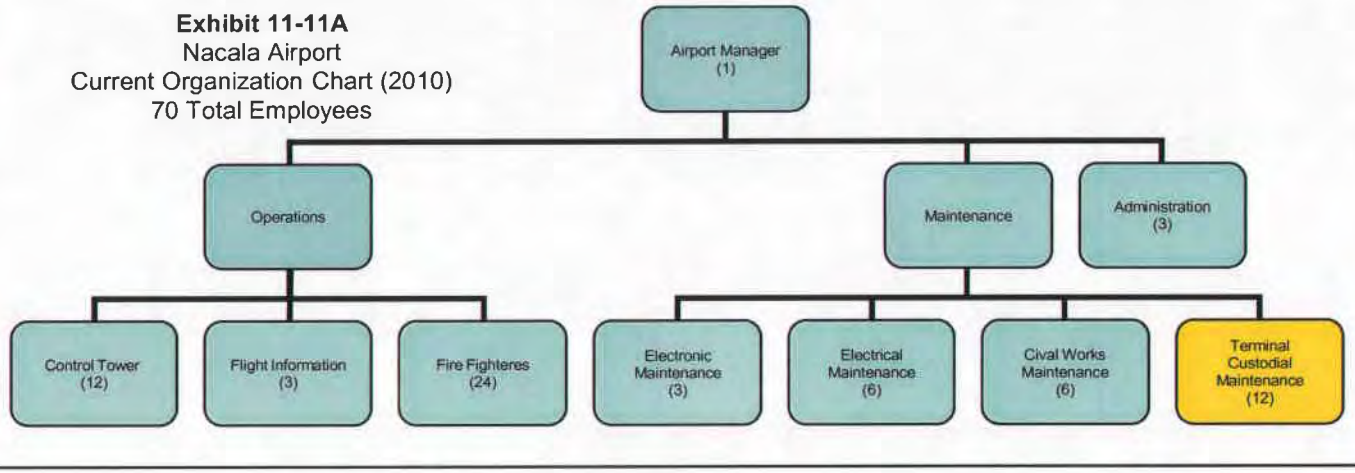
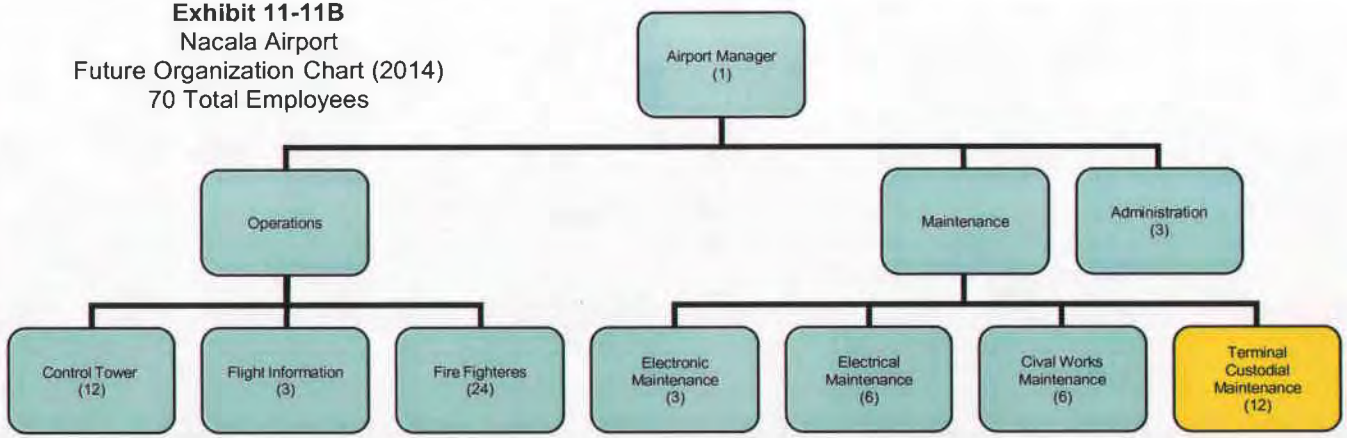


Exhibit 11-11B
Nacala Airport
Future Organization Chart (2014)
70 Total Employees



Source: ARROTEC Infrastructure Group, Inc.

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SECTION 12 DEVELOPMENTAL IMPACT CONSIDERATIONS

The present section of this report describes the development impact factors associated with the implementation of the proposed project and is intended to provide Mozambican decision-makers and other interested parties with a broad view of its potential effects on the country in general and the environs of Nacala in particular.

The proposed conversion of the Nacala military airfield to a civilian airport capable of accommodating domestic, regional and international commercial air services will have a significant impact on the economic and social development of the surrounding region. In particular, it will have an immediate and direct impact in improving the capacity of the regional infrastructure and the competitivity of local industry (including tourism); it will also contribute indirectly to the implementation of market-oriented reforms, the optimization of human capacity, the transfer of technology and the enhancement of productivity. The following sections provide estimates of the Project's potential benefits in these specific sectors.

12.1 Infrastructure and Industry

12.1.1 Basic Regional Infrastructure

Implementation of the proposed airport development program at Nacala will provide a key missing component of transportation infrastructure to the city and its surrounding area. At present, the city, port and nearby recreational zones of Nacala do not have direct access to air transportation; the closest airport is located at Nampula, requiring a trip of approximately 3 hours by road. The proposed new airport facilities will therefore complement the existing maritime, rail and road infrastructure serving the area, thus providing the region with a complete network of links to the outside world. Since the existence of a balanced multi-modal transportation system is a pre-requisite for economic growth, the new airport facilities will act as a lever for maximizing the potential of the sub-region.

The Nacala region already has the much of the basic infrastructure necessary for makings of a dynamic economic center, in the form of excellent port facilities and adequate rail and road links and new industrial/commercial facilities are being built in the area. The port and rail facilities at Nacala have been cited already by the UNDP and other international and regional agencies as an essential gateway to vast hinterland extending into the neighboring countries of Malawi, Zambia and Zimbabwe. The proposed airport project will thus form part of an integrated and balanced transportation infrastructure network serving a region with great potential; it is not an isolated investment. The role of the airport improvement project as a catalyst for the completion of this larger network is thus critical as part of a regional infrastructure development strategy.

12.1.2 Industrial Development

The implementation of the airport project will also contribute significantly to making the industries of the Nacala more competitive both within Mozambique and at the regional level of Southern Africa. Access to efficient air transportation for the movement of people and goods is a prerequisite for success in attracting and retaining high-value businesses to an area such as Nacala. Once again, the fact that the airport improvement project will take place in a region of industrial expansion makes the "leverage" of the proposed airport investment more effective.

In this context, it is recommended that the local Nacala authorities, together with ADM, establish an industrial development strategy to capitalize on the airport investment. This would involve reserving land in the vicinity of the airport for the attraction of compatible industries and ensuring good road connections between the airport and existing industrial development zones, as well as marketing the potential of the Nacala area to outside investors.

12.1.3 Tourism

Finally, the nascent tourism industry in the Nacala region will benefit substantially from the implementation of the proposed airport development project. In fact, this sector will probably be the most immediate beneficiary of the proposed investment. Although the Nacala region enjoys undeniable potential for tourism as a result of the quality of its beaches, historical sites and underwater phenomena, the availability of good air access to international source markets constitutes a *sine qua non* for the development of this resource. Without airport facilities capable of accommodating flights from these markets, it is highly unlikely that any significant private investments will be made to develop the kind of hotel/resort infrastructure that will attract international tourists.

In this context, the development of the airport will have the effect of stimulating and creating the essential basic conditions required to attract private investment to develop the infrastructure associated with a high-quality, sustainable tourism product. As with the industrial development strategy mentioned in the previous section, it is recommended that the local Nacala authorities establish a clear tourism development strategy to capitalize on the airport investment. This would involve the definition and protection of priority zones, the establishment of development standards and the training of personnel, as well as marketing the potential of the Nacala area to outside investors and international tourism operators and tour packagers.

Tourism Trends

Travel and tourism is a vital economic sector with an estimated 10.6% share of global GDP. It is also a labor intensive sector, generating about 8.3% of global employment or jobs for around 220 million people and accounting for over 10% of total employee

wages and salaries around the world. The tourism sector is the world's largest tax payer and accounts for about 25% of world trade in services. Tourism is the world's fastest growing industry and is predicted to become the world's largest outside agriculture in absolute terms by 2010.

In the past 55 years, global international tourism arrivals have grown by an average 7% per annum – from 25 million person-trips in 1950 to 760 million today. International tourism receipts have grown from US$2 billion in 1950 to US$622 billion in 2004 world wide – an annual growth rate of 11% mainly due to an increase in receipts per international arrival.

Sub-Saharan Africa has experienced remarkable growth in tourism in the past two decades. First, the region's market share of international arrivals increased from 1.5% in 1970 to 4.5% in 2003. That trend is projected to continue in 2005-2020, increasing Africa's share to 5% of total international arrivals by 2020. In Africa, the fastest-growth markets are Southern and Eastern Africa (including Mozambique), jointly accounting for 15 million or 52% of total arrivals to Africa.

Mozambique has taken its fair share of the growth of the African market. Since the peace-accord in 1992, international arrivals of tourists to Mozambique have grown rapidly from 240,000 in 1999 to some 470,000 by 2004, an annual growth rate of about 13%. This growth rate, however, is from a low level in absolute terms. Tourists per 100 inhabitants respectively, both Africa and Mozambique compare rather unfavorably to a world average of 11 tourists per 100 inhabitants.

Tourism Receipts

According to data from the World Tourism Office (WTO) international tourism receipts in Mozambique amounted to US$106 million in 2002. In terms of expenditures by individual tourists, spending in Mozambique has been comparatively low and therefore presents opportunities for growth. Average international receipts per arrival vary widely across the world. In 2002, global average receipts were US$675 per arrival; in Africa, these were lower at an average of US$404 in 2002. International tourism receipts per international arrival in Mozambique reached US$240 in 2003 – well short of the unit price in Africa (US$404) and the world (US$675), as illustrated by the following figures. The difference is mainly explained by shorter average lengths of stay.

Tourism Receipts per International Arrival (2002)*	
World	(US$)675
Africa	(US$)404
Europe	(US$)602
Middle East	(US$)470
Americas	(US$)995
Asia and Pacific	(US$)721
Mozambique	**(US$)240**

*Source: World Tourism Organization

12.2 Market-Oriented Reforms

As described in the preceding section, the optimization of the investment to be made at the airport will depend on the extent to which the local authorities join forces with ADM to manage the industrial, commercial and tourism development generated by the airport activities. In this regard, it is recommended that the necessary land-use control mechanisms be put into place so as to ensure that such development takes place in an orderly and sustainable manner.

At the same time, the local authorities should ensure that the necessary legal instruments are in place to control encroachment by residential and other non-compatible land uses under the sensitive areas around the airport, thus compromising the safety of flight operations, causing nuisance to the populations and limiting the long-term expansion of aviation activities.

Finally, the implementation of new airport facilities at Nacala should be accompanied by confirmation on the part of the Government to ensure the economic deregulation of the Mozambique air transport market and, in particular, the application of the letter and the spirit of the Yamoussoukro Decision Regarding the Liberalization of Air Transportation on Africa.

12.3 Human Capacity Building

The implementation of the new civilian airport facilities will generate an estimated total of over 70 jobs in the airport administration alone. A description of the number and type of positions that would be needed in the airport administrative staff is given in the section of this report which details the financial aspects of the project. The managerial level positions will all require specialized training, to be arranged through ADM and including management skills, safety/security and airport maintenance procedures, facilitation, etc.

In addition, the direct creation of other jobs at the airport will include those of airlines, aircraft ground handling agencies, taxis, freight forwarders and cargo operators, flight kitchens, aircraft refueling depots, car rental agencies, concessionaires, etc. It is estimated that employment at the airport itself will account for approximately 120-150 permanent jobs within 10 years of the opening of the new facilities. The airport construction program will also account for a considerable number of jobs, although these will not be permanent.

In addition to the employment opportunities created at the airport, the air traffic activity will create significant indirect employment in the Nacala area for suppliers of various services to operators at the airport, as well as through the "multiplier" effect generated by direct airport employment. Finally, the development of the airport will stimulate industrial/commercial activity in the Nacala region as described above and will create the essential conditions for the realization of the

significant tourism potential of the area. Taken together, the employment generated by such economic activities will number well into the thousands, although it is not possible to indicate a specific number at this point in time.

12.4 Technology Transfer and Productivity Enhancement

Implementation of the project will involve the use of a number of advanced technologies in the areas of telecommunications and air navigation equipment. It will also introduce airline reservation systems (software and hardware) into the local economy. The most significant enhancement of productivity, however, will result from the improvement of access to markets for the region's products, whether in the field of industrial/agricultural production or tourism.

12.5 Other

Finally, the development of commercial airport facilities will have the intangible effect of granting Nacala the ability to demonstrate to the world that their region is part of the global aviation network. This will enable the tourist industry to explore the beauty and hidden treasures of this Mozambique region.

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APPENDIX: LIST OF POTENTIAL U.S. SUPPLIERS

INTRODUCTION

According to the Terms of Reference of this study and to meet the requirements of the USTDA, a general list of potential U.S. sources of equipment, materials and services for the future implementation of improvements at the Airports of Mozambique is provided in the present Appendix. AAROTEC agrees with the Difinitional Mission Study in that the export benefits for US Suppliers could exceed US$26 million over the life of the project. U.S. labor could open business opportunities in Mozambique for U.S. manufacturers and design, engineering and consulting firms as well as the training of local operators and airport staff.

The names and addresses of the firms which are named are divided into categories of equipment and services which focus on airport operations.

1. Loading Bridges

Jetway Systems, Inc.
1805 W 2550 South
Ogden, UT 84401
United States
Phone: 801-627-6600
Fax: 801-629-3474
Email: sales@jetwaysystems.com

Dewbridge Airport Systems
1350 College Avenue
Canon City, Co 81212
United States
Phone: 719-276-1772
Fax: 719-276-1773
Email: sales@dewbridge.com

Thyssen Stearns, Inc.
3201 N Sylvania Avenue, Suite 100E
Ft Worth, TX 76111
United States
Phone: 817-834-6984
Fax: 817-834-6985
Email: sales@tyssen-stearns.com

2. Apron and Airfield Lighting

Honeywell
21111 North 19th Avenue (N19A5)
Phoenix, AZ 85027
United States
Phone: 602-436-5307
Fax: 602-436-5300
Email: sales@honeywell.com

Venture Lighting International
32000 Aurora Road
Solon, OH 44139-2814
United States
Phone: 216-248-0600
Fax: 216-349-7171
Email: salesinfo@venturelightingintn.com

Siemens Energy and Automation, Inc.
3333 Old Milton Parkway
Alpharetta, GA 30005
United States
Phone: 800-964-4114
Email: usa.800siemens.us@siemens.com

ADB, A Siemens Company
977 Gahanna Parkway
PO Box 30829
Columbus, OH 43230-0829
United States
Phone: 614-573-8225
Fax: 614-573-8325
Email : elvis.iimenez@sas.siemens.com www.sas.siemens.com

Airport Lighting Systems
10661 Shady Trail
Dallas, TX 75220
United States
Phone: 800-962-6574
Fax: 214-366-0922
E-mail: questions@airportlighting.com www.airportlighting.com

Flight Light, Inc.
3513 La Grande Boulevard

Sacramento, CA 95823-1010
United States
Phone: 916-394-2800
Fax: 916-394-2809
Email : dan.statum@flight.com www.flightlight.com

Honeywell Airport Systems
2162 Union Place
P.O. Box 2167
Simi Valley, CA 93062
United States
Phone: 805-581-5591
Fax: 805-581-5032
Email : lighting.webrequest@honeywell.com www.lblighting.com

3. Navigational Aids

Airport Systems International
11300 West 89th Street
Overland Park, KS 66214-1176
United States
Phone: 913-495-2609
Fax: 913-492-0870
Email: jwharton@airportstemsinternational.com

Advanced Navigation & Positioning Corporation
11 Third Street
Hood River, OR 97031
United States
Toll Free: 800-228-1857
Fax: 541-386-2124
Email: sales@anpc.com

New Bedford Panoramex Corporation
1037 West Ninth Street
Upland, CA
United States
Phone: 909-982-9806
Fax: 909-982-9810
Email:sales@nbpcorp.com

Raytheon Company
141 Spring Street
Lexington, MA 02421
United States

Phone: 781-862-6600
www.raytheon.com

Tiger Corporation
3301 North Louise Avenue
Sioux Falls, SD 57107
United States
Phone: 605-336-7900
Fax: 605-338-9702
Email : riensen@tiger-mowers.com www.tiger-mowers.com

Hi-Lite Markings, Inc.
18249 Hi-Lite Drive
P.O. Box 350
Adams Center, NY 13606-0350
United States
Phone: 315-583-6111
Toll Free : 800-843-6849
Fax: 315-583-5807 (800-716-7620/toll free)

Roads & Runways Striping Service Incorporated
P.O. Box 6514
Daytona Beach, FL 32118
United States
Phone: 904-255-4521
Fax: 904-238-1438

Speidel Construction, Inc.
105 N Main Street
Culpeper, VA 22701
United States
Phone: 540-825-9660
Fax: 540-825-9088
Email : info@cleanrunways.com www.cleanrunways.com

4. Ground Service and Cargo Handling Equipment

Trowin Industries, Inc.
800 Wisconsin Street, Bldg 15
P.O. Box 1778
Eau Claire, WI 54703
United States
Phone: 715-839-7966
Fax: 715-833-2181

Email: info@trowin.com

Airport Group International
330 N Brand Boulevard, Suite 300
Glendale, CA 91203-2308
United States
Phone: 818-409-7500
Fax: 818-409-7979
Email: sales@airportgroupinternational.com

Rapistan Systems
507 Plymouth Avenue NE
Grand Rapids, MI 49505-6098
United States
Phone: 616-451-6525
Fax: 616-451-6425
Email: esterland@rapistan.com

5. Preconditioned Air and 400 Htz Power

INET Airport Systems
1871 South Chris Lane
Anaheim, CA 92805
United States
Phone: 714-978-8484
Fax: 714-978-8460
Email: retupack@inetas.com

Aviation Ground Equipment Corporation
53 Hanse Avenue
Freeport, NY 11520
United States
Phone: 516-546-0003
Fax: 516-546-0198
Email: sales@aviationgroundequip.com

Hobart Ground Power
1177 Trade Road E
Troy, OH 45373-2479
United States
Phone: 937-332-5549
Fax: 937-332-5335
Email: salesinfo@hobart.com

6. Aircraft Docking Guidance Systems

RLG International
12964 Moorpark Street
Studio City, CA 91604
United States
Phone: 213-872-1738
Fax: 818-990-6841
Email: rlgaugenmaier@rlg.com

PDI Ground Support Systems, Inc.
5905 Grant Avenue
Cleveland, OH 44105-5609
United States
Phone: 216-271-7344
Fax: 216-271-7550

Honeywell, Inc.
5353 West Bell Road
Phoenix, AZ 85308-9000
United States
Phone: 602-822-4536
Fax: 602-822-4777
Email: systems@honeywell.com www.honeywell.com

7. Hydrant Refueling Systems

Determan Brownie, Inc.
1241 72nd Avenue NE
Minneapolis, MN 55432
United States
Phone: 763-571-1744
Fax: 763-571-1789
Email: sales@determan.com

Applied Technology, Inc.
3125 Sterling Circle W, Suite 107
Bolder, CO 80301
United States
Phone: 303-444-3590 x21
Fax: 303-444-8736
Email: danderson@ap-tech.com

James A. Staley Co.
5 Bowen Court

Carmel, NY 10512
United States
Phone: 845-878-3344
Fax: 845-878-3429
Email: test.equipment@staleyco.com

8. Airport Ground Support Equipment

Taylor-Dunn Manufacturing Co.
2114 West Ball Road
Anaheim, CA 92804
United States
Phone: 714-956-4040
Fax: 714-956-3131
Email: contact@taylor-dunn.com

Radiant Aviation Services
40 Centre Drive
Orchard Park, NY 14127-4102
United States
Phone: 716-662-0022
Fax: 716-662-0033
Email: sales@radiantenergycorp.com

Charlatte of America
600 Mountain Lane
P.O. Box 968
Bluefield, Virginia 24605
United States
Phone: 276-326-1510
Fax: 276-326-1602
Email: equipmentsales@charlattius.com

Cage, Inc.
1303 Walnut Hill Lane, Suite 140
Irving, TX 75038
United States
Phone: 972-550-1001
Fax: 972-550-9221
Email : spredioer@caoe-inc.com www.caoe-inc.com

9. Baggage Conveyors

BAI Automated Systems, Inc.
2525 Carter Drive

Carrollton, TX 75006
United States
Phone: 972-389-6242
Fax: 972-389-6490
Email: sales@bai-inc.com www.bai-inc.com

Airport Group International
330 N Brand Boulevard, Suite 300
Glendale, CA 91203-2308
United States
Phone: 818-409-7500
Fax: 818-409-7979
Email: info@airportgroupinternational.com

G & T Conveyor Company, Inc.

476 Southridge Industrial Drive
Tavares, FL 32778
United States
Phone: 352-343-1500
Fax: 352-343-5077
Email: sales@gtconveyor.com

Cage, Inc.
1303 Walnut Hill Lane, Suite 140
Irving, TX 75038
United States
Phone: 972-550-1001
Fax: 972-550-9221
Email : spedioer@caoe-inc.com www.caoe-inc.com

Division Systems
5680 E Shelby Drive
Memphis, TN 38141-5816
United States
Phone: 901-366-4220
Toll Free : 800-544-8442
Fax: 901-365-3934
Email : info@divisionsystems.com www.divisionsystems.com

IDmicro, LLC
1019 Pacific Avenue, 13th Floor
P.O. Box 1795 (98401)
Tacoma, WA 98402
United States

Phone: 253-396-1479
Fax: 253-396-1478
Toll Free: 877-395-1479
Email : info@idmicro.com www.idmicro.com

Professional Conveyor Service
P.O. Box 1118
Bristol, CT 06011-1118
United States
Phone: 860-582-9816
Fax: 860-589-9157

Vic Thompson Company
2738 SE Loop 820
Ft. Worth, TX 76140
United States
Phone: 817-293-7600
Fax: 817-293-8856

10. Escalators/Elevators

Otis Elevator, Inc.
10 Farm Springs Road
Farmington, CT 06032
United States
Phone: 860-676-6000
Fax: 860-676-5111
Email: sales@otis.com www.otis.com

Stanley Elevator Company, Inc.
Nine Henry Clay Drive
Merrimack, NH 03054
United States
Phone: 603-882-6918
Fax: 603-882-8818
Email: palcorn@stanleyelevator.com www.stanleyelevator.com

ESI Elevator Systems, Inc.
207 Lawrence Avenue
Inwood, NY 11096
United States
Phone: 516-239-4044
Fax: 516-239-5793
Email: info@elevatorsystems.com www.elevatorsystems.com

11. Flight Information Display Systems (FIDS)

International Display Systems
3131 South Dixie
Dayton, OH 45439
United States
Phone: 303-858-1000
Fax: 303-858-1100
Email: ids-inc@msn.com

Clarity Visual Systems
9025 SW Hillman Court, Suite 3122
Wilsonville, OR 97070
United States
Phone: 503-570-0443
Fax: 503-582-8570
Email: info@clarityvisual.com

Com-Net Software Specialists
8905 Castleberry Road
Apex, NC 27502
United States
Phone: 919-362-6122
Email: sales@com-net.com

12. Security Surveillance Systems

Siemens America Building Technologies, Inc.
1000 Deerfield Parkway
Buffalo Grove, IL 60089
United States
Phone: 847-215-1050
Fax: 847-215-8326
Email: sales@siemens.com www.siemens.com

Access
1011 U. S. Hwy 22 E
Mountainside, NJ 07092
United States
Phone: 908-789-8700 X 222, 877-949-6700 X 222
Email: info@access-controlled.com

Safeguards Technology, Inc.
75 Atlantic Street
Hackensack, NJ 07601

United States
Phone: 201-488-1022
Fax: 201-488-1244
Email : marketing@safeguards.com www.safeguards.com

Passenger Security Screening Equipment

Barringer Technologies Inc.
30 Technology Drive
Warren, New Jersey 07059
Phone : 908-222-9100
Fax : 908-222-1557
Email : info@barringer.com www.barringer.com

Invision Technologies
World Headquarters
7151 Gateway Boulevard
Newark, CA 94560
Phone : 510-739-2400
Fax : 510-739-6400
Email : info@invision.iip.com sales_admin@invision.iip.com www.invision-tech.com

Baggage Explosive Detection Systems

GE Ion Track
205 Lowell Street
Wilmington, MA 01887
Phone : 1-800-433-5346
Fax : 1-866-249-9105
Email : geiontracksales@ge.com

Reveal Imaging Technologies, Inc.
201 Burlington Rd.
Bedford, MA 01730
Phone : 781-276-8400
Fax : 781-276-8410
Email : sales@revealimaging.com

13. Security Screening Services

ADT Security Services, Inc.
3601 Eisenhower Avenue, 3rd Floor
Alexandria, VA 22304-6425
United States

Phone: 703-317-4203

World Institute for Security Enhancement
Post Office Box 4646
Miami Lakes, Fl 33014-0646
United States
Phone: 305-825-0088 305-766-0170
Fax: 954-447-5184
Email: securitytraining@pobox.com

Lockheed & Covenant Security Solutions
9231 Corporate Boulevard
Rockville, MD 20850
United States
Phone: 301-640-30416
Fax: 301-640-2144
Email: sean.reineke@lmco.com

14. Rescue and Fire Fighting Equipment

Oshkosh Truck Corporation
2307 Oregon Street
Oshkosh, WI 54901-7000
United States
Phone: 414-235-9151
Fax: 920-832-3208
Email : info@oshkosh.com

Horton Emergency Vehicles
3800 McDowell Road
Grove City, OH 43123
United States
Phone: 614-539-8181
Fax: 614-539-8165
Email : sales@horton.com

American Emergency Vehicles
165 American Way
Jefferson, NC 28640
United States
Phone: 336-982-9824
Toll Free : 800-374-9749
Fax: 336-982-9826
Email: info@AEV.com www.AEV.com

Esco
10 Industrial Highway, MS No. 38
Lester, PA 19113
United States
Phone: 610-595-2840
Fax: 610-595-2842
Email : mberquist@esco-usa www.esco-usa.com

Globe Firefighter Suits
9216 Bellhaven Avenue N.E.
Albuquerque, NM 87112-3819
United States
Phone: 800-895-7540
Fax: 603-435-6388
Email : globalsales@globefiresuits.com www.globefiresuits.com

Lumastrobe (Precision multicontrols)
33 Greenwood Avenue
Midland Park, NJ 07432
United States
Mr. Peter Zecher
Phone: 201-444-0600
Fax: 201-445-8575
Email : precision@precisionmulticontrols.com www.precisionmulticontrols.com

Medrotect, Inc.
1900 Preston Road, Suite 267
Plano, TX 75093
United States
Phone: 800-945-4158, 972-612-1515
Fax: 972-867-3063
Email : medpro@medprotect-inc.com www.medprotect-inc.com

Off The Wall Products, LLC
423 S 600 W
P.O. Box 1461 (84110)
Salt Lake City, UT 84101
United States
Phone: 801-363-7740
Fax: 801-363-6372
Toll Free: 888-363-7740
Email : patricia@multi-barrier.com www.multi-barrier.com

Environfuel, Inc./"E III" Envirofluid
1613 Kennedy Avenue

Blacksburg, VA 24060-5731
United States
Phone: 540-552-0001
Fax: 540-552-0002
www.cpchem.com

Pro-Tec Fire Services, Ltd.
2129 South Oneida Street
Green Bay, WI 54304
United States
Phone: 920-494-8851
Toll Free: 800-242-6352
Fax: 920-494-5384
Email : info@protecfire.com www.protecfire.com

15. Waste Water Treatment

AAROTEC Infrastructure Group
401 Ponderosa Trail, Suite 200
Bunker Hill, WV 25413
United States
Phone: 304-821-1001
Fax: 703-255-3703
Email: aarotec@aarotec.com www.aarotec.com

Bio-Systems International
1238 E Inman Parkway
Beloit, WI 53511
United States
Phone: 608-365-9550, 608-365-9952
Toll Free : 800-232-2847
Fax: 608-365-9467, 608-364-9953 (866-870-8163/toll free)
Email : info@biobugs.com www.biobugs.com

Straughan Environmental Services, Inc.
3905 National Drive, Suite 105
Burtonsville, MD 20866-1100
United States
Phone: 301-989-3265
Fax: 301-989-3271

Email: estraughan@sesenviron.com

16. Cargo Handlers/Developers

Aviation Facilities Company, Inc.
7600 Colshire Drive, Suite 240
McLean, VA 22102
United States
Phone: 703-902-2900
Fax: 703-902-2901
Email: fchambers@afcpom.com

Airports Group International
330 N. Brand Boulevard, Suite 300
Glendale, CA 91203-2308
United States
Phone: 818-409-7500
Fax: 818-409-7979
Email : info@airportgroupinternational.com

The LZA Group
51 Madison Avenue
New York, NY 10010-1603
United States
Phone: 917-661-7800
Fax: 917-661-7801
Email: agutman@lzagroup.com www.lzagroup.com

17. Ground Transportation Equipment

Aviation Ground Equipment Corp.
53 Hanse Avenue
Freeport, NY 11520
United States
Phone: 516-546-0003
Fax: 516-546-0198
Email : info@aviationgroundequipment.com

Oshkosh Truck Corporation
2307 Oregon Street
Oshkosh, WI 54901-7000
United States
Phone: 414-235-9151
Fax: 920-832-3208
Email : sales@oshkosh.com

ShuttlePort, an ATC/Vancon Company
1 Mid America Plaza, Suite 401
Oakbrook Terrance, IL 60181-4704

United States
Phone: 630-571-7070
Fax: 630-571-3969
Email: fjreiter@vanderamamobility.com

18. Terminal Building HVAC Systems

York International Corporation
631 South Richland Avenue
York, PA 17405
United States
Phone: 717-771-7890
Fax: 717-771-7381
Email: sales@york.com www.york.com

The Trane Company
Lynn Haven, Florida
United States
Phone: 301-984-2400
www.trane.com

Carrier Corporation
P.O. Box 4008 Carrier Parkway, TR-20
Syracuse, NY 132214805
United States
Phone: 315-432-3322
Toll Free : 800-227-7437
Fax: 315-432-3099
www.commercial.carrier.com

19. Terminal or Airport Facilities Equipment

Lavi Industries
27810 Avenue Hopkins
Valencia, CA 91355-3409
United States
Phone: 661-219-3144
Fax: 661-775-9850
Toll Free: 800-624-6225, 888-285-8605
Email: eddvs@lavi.com www.lavi.com

Lighting

Wide-Lite
P.O. Box 606

San Marcos, TX 78667
United States
Phone: 512-392-5821
Fax: 512-753-1122
Email: info@widelite.com www.wide-lite.com

Furnishings and Refrigeration for Terminal and Cargo Facilities

The Hon Company
200 Oak Street
Muscatine, Iowa 52761
United States
Toll Free: 800-624-9212
Fax: 800-328-7257
www.hon.com

Partners & Thompson, Inc.
41 Keyland Court
Bohemia, NY 11716-2617
United States
Phone: 631-589-7337
Fax: 631-589-7339
Email: info@kusch.com www.kusch.com

Hobart Corporation (kitchen, refrigeration)
701 S Ridge Avenue
Troy, OH 45374-0001
United States
Phone: 937-332-3000
Fax: 937-332-2585
www.hobart.com

Steelcase
11798 N Lakeridge Parkway
Ashland, VA 23005-8152
United States
Phone: 804-329-0400
Fax: 804-321-3144
Email: sales@creative-va.com www.creative-va.com

Roofing

Advanced Coating Systems, Inc.
645 Molly Lane, Suite 130
Woodstock, GA 30189

United States
Phone: 678-445-0040
Fax: 678-445-0399
Email: sales@acsiusa.com

Carlisle Corporation (Syntec) or (Eco Star)
1285 Ritner Highway
P.O. Box 7000
Carlisle, PA 17013
United States
Phone: 717-245-7000
Toll Free : 800-479-6832
Fax : 717-245-7053
Email: info@carlisle.com www.carlisle-syntec.com www.ecostar.carlisle.com

Atlas Roofing Corporation
2000 Riveredge Parkway, Suite 800
Atlanta, GA 30328
United States
Phone: 770-952-1442
Email: http:www.atlasroofing.com

Flooring

ICA
1280 N Winchester
Olathe, KS 66061
United States
Phone: 913-780-0770
Email: rcain@insulcorp.com

Interface Flooring Systems, Inc.,
1503 Orchard Hill Road
LanGrange, GA 30240
United States
Phone: 706-882-1891
Toll Free : 800-336-0225
Fax: 706-884-8340 706-882-0500
Email : info@interfaceflor.com

Armstrong World Industries
2500 Columbia Avenue
Lancaster, PA 17603
United States
Phone: 717-397-0611

Fax: 877-276-7876
Email: flooring@armstrong.com_Http://www.armstrongworld.com

Milliken and Company
201 Lukken Industrial Drive W
LaGrange, GA 30240
United States
Phone: 706-880-5415
Fax: 706-880-5906
http://www.milliken.com

Curtain Walls

Walls + Forms, Inc.
850 Northlake Drive
Coppell, TX 75019
United States
Phone: 972-745-0800
Fax: 972-304-8402
Email: dweddle@wallsforms,com

H.H. Robertson Company
450 19th Street
Ambridge, PA 15003
United States
Phone: 412-299-8074
Fax: 412-299-8402
Email: sales@hhrobertson.com www.hhrobertson.com

Doors and Door Controls

Door Engineering & Manufacturing
400 Cherry Street
Olathe, KS 66061
United States
Phone: 913-780-0770
Email: rcain@insulcorp.com

Cottonwood Welding & Manufacturing, Inc.
3940 Oak Park Circle
Rochester, MN 55904
United States

Phone: 507-282-1583
Fax: 507-423-5609

Email: sales@hydroswing.com www.hydroswing.com

Agile Access Control, Inc.
1999 S Bascom Avenue, Suite 700
Campbell, CA 95008
United States
Phone: 703-968-7300
Toll Free : 866-539-2668
Fax: 703-832-8729
Email: sales@agileaccesscontrol.com

Automated Building Systems

ElectroCom Automation, L.P.
P.O. Box 95080
Arlington, Texas 76005-1080
United States
Phone: 817-695-7584
Fax: 817-695-3015
Email: sales@electrocomautomation.com www.electrocomautomation.com

Agile Access Control, Inc.
1999 S Bascom Avenue, Suite 700
Campbell, CA 95008
United States
Phone: 703-968-7300
Fax: 703-832-8729
Email: sales@agileaccesscontrol.com

Sentry Technology Corporation
350 Wireless Boulevard
Hauppauge, NY 11788
United States
Phone: 516-881-2084
Email: products@sentrytechnology.com www.sentrytechnology.com

Cladding

Starnet International Corporation
200 Hope Street
Longwood, Fl 32750
United States
Phone: 407-830-1199
Fax: 407-830-1817
Email: info@starnetint.com

Reynolds Metal Company
201 Isabella Street
Pittsburgh, PA 15212-5858
United States
Phone: 412-553-4545
Fax: 412-553-4498
Email: http://www.alcoa.com

Lawrence Metal Products, Inc.
260 Spur Drive S
P. O. Box 400-M
Bay Shore, NY 11706-3917
United States
Phone: 631-666-0300
Toll Free : 800-441-0019
Fax: 631-666-0336
Email: sales@lawrencemetal.com www.lawrencemetal.com

Closed Circuit TV

Javelin Technologies
19831 Magellan Drive
Torrance, CA 90502
United States
Phone: 877-219-6757

PI Vision
4370 L.B. McLeod Road
Maitland, FL 32811
United States
Phone: 407-540-1252
Email: bobd@pi-vision.com

Infinova
51 Stouts Lane
Monmouth Junction, NJ 08852
United States
Phone: 732-355-9100
Fax: 732-355-9101
Email: sales@infinova.net

Signs

Daktronics, Inc.
331 32nd Avenue
P.O. Box 5128
Brookings, SD 57006-5128
United States
Phone: 605-697-4000

Clarity Visual Systems
9025 SW Hillman Court, #3122
Wilsonville, OR 97070
United States
Phone: 503-570-0443
Fax: 503-582-8570
Email: sales@clarityvisual.com

NEC-Mitsubishi Electronics Display of America
500 Park Boulevard, Suite 1100
Itasca, IL 60143
United States
Toll Free : 800-632-4662
Email: sales@NEC.com

Gates

Master-Halco, Security Solutions Group
4000 W Metropolitan Drive, Suite 400
Orange, CA 92868
United States
Phone: 800-989-4526
Email: securitysolutions@masterhalcosecurity.com

Hy-Security Gate Operators
408 North 35th Street
Seattle, WA 98103
United States
Phone: 206-632-0538
Fax: 206-632-2404
www.ly-securitygateoperators.com

Transpo Industries, Inc.
20 Jones Street
New Rochelle, NY 10801
United States

Phone: 914-636-1000
Fax: 914-636-1282
Email: info@transpo.com

Suspended Ceilings

ICA
1280 N Winchester
Olathe, KS 66061
United States
Phone: 913-780-0770
Email: rcain@insulcorp.com

Armstrong World Industries
2500 Columbia Avenue
Lancaster, PA 17603
United States
Phone: 717-397-0611
Fax: 877-276-7876
Email : ceilings@armstrong.com

Acoustic Ceiling Products, LLC
P.O. Box 1581
Appleton, WI 54912-1581
United States
Phone: 920-735-3751
Toll Free : 800-434-3750
Fax: 920-734-9786
Email: sales@acpideas.com www.acpideas.com

Skylights

Bristolite Skylites
401 E Goetz Avenue
Santa Anna, CA 92707
United States
Phone: 714-540-8950
Email : skylites@bristolite.com

American Skylites, Inc.
525 113th Street
Arlington, TX 76011
United States
Phone: 817-633-4666
Toll Free : 800-772-7401

Fax: 817-633-4616
Email: ksuttles@americanskylites.com www.americanskylites.com

Crystalite, Inc.
3307 Cedar Street
Everett, WA 98201
United States
Phone: 425-259-6000, 425-745-6000
Toll Free : 800-666-6065
Fax: 425-258-6734 (800-445-7282/toll free)
Email: info@crystaliteinc.com www.crystaliteinc.com

Fire Alarms, Sprinkler Systems

Simplex/Grimmel Systems
22712 Commerce Center Court
Dulles, VA 20166
United States
Phone:703-996-0782
Fax: 703-996-8202
Email : sales@simplex/grimmelsystems.com

Icon Service Company
20016 State Road
Cerritos, Ca 90703
United States
Phone: 562-809-3066
Fax: 562-865-5711
www.iconserviceco.com

Honeywell, Inc.
5353 West Bell Road
Phoenix, AZ 85308-9000
United States
Phone: 602-822-4536
Fax: 602-822-4777
Email: systems@honeywell.com www.honeywell.com

Coserv Security
3501 FM 2181
Denton, TX 76205
United States
Phone: 214-747-6500
Fax: 214-747-6555
Email : contact@coserv.com www.coserv.com

Halotron, Inc.
3770 Howard Hughes Parkway, Suite 300
Las Vegas, NV 89169
United States
Phone: 702-735-2200
Fax: 702-735-4876
Email : halotron@apfc.com www.halotron-inc.com

20. CNS/ATM, Meteorological, and ATC Related Equipment

Controller Displays

Tech-Source, Inc.
3340 Edgewater Drive
Olando, FL 32804
United States
Phone: 407-262-7100
Toll Free : 800-330-8301
Fax: 407-339-2554
Email : info@techsource.com www.techsource.com

Communications (Recorders)

Advanced Integrated Recorders
121 Whittendale Drive, Building 1
Moorestown, NJ 08057
United States
Phone: 856-234-5020
Fax: 856-234-5242
Email : danc@air.formation.com www.air2000.formation.com

Comverse USA
234 Crossways Park Drive
Woodbury, NY 11797
United States
Phone: 516-677-7400
Fax: 516-677-7197
Email : marketing@cominfosys.com www.cominfosys.com

Dictaphone Corporation
3191 Broadbridge Avenue
Stratford, CT 06614-2559
United States
Phone: 203-381-7000

Fax: 203-386-8597
www.dictaphone.com

Lanier Worldwide
2300 Parklake Drive NE
Atlanta, GA 30345
United States
Phone: 770-496-9500
Fax: 770-491-1534
www.lanier.com

Meteoroligical (Weather Systems) Handar
1288 Reamwood Avenue
Sunnyvale, CA 94089
United States
Phone: 408-734-9640
Fax: 408-734-0655
Email : marketing@handar.com www.handar.com

Nova Lynx Corporation
PO Box 240
Grass Valley, CA 95945
United States
Phone: 530-823-7185
Fax: 530-823-8997
Email : nova@novalvnx.com www.novalvnx.com

Qualimetrics
1165 National Drive
Sacramento, CA 95834
United States
Phone: 916-928-1000
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Email : qual@oualimetrics.com www.aualimetrics.com

Rain Wise
25 Federal Street
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Email : sales@rainwise.com www.rainwise.com

Systems Management Incorporated
10946 Golden W Drive, Suite 100
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Fax: 410-229-7603
Email : petra@awi-smi.com www.awi-smi.com

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Arinc Incorporated
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Toll Free : 800-633-6882
Fax : 410-266-2329
www.arinc.com

Aydin Telemetry
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Mentor Radio Company (Air Services of Cleveland)
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Fax: 216-267-2915
www.mentorradio.com

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Fax: 732-404-2580
Email : info@rcc.com www.rcc.com

Harris Corporation (RF Communications)
1025 West NASA Boulevard
Melboume, Florida 32919-0001
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Email : webmaster@harris.com www.harris.com

Motorola
1303 E Algonquin Road
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United States
Phone: 847-576-5000 www.mot.com

Rockwell Collins
400 Collins Road NE
Cedar Rapids, IA 52498
United States
Phone: 319-295-1000
Fax: 319-295-5429
Email : mktosvcs@collins.rockwell.com www.collins.rockwell.com

Sensis Corporation
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Phone : 315-445-0550
Fax: 315-445-9401
Email : info@sensis.com www.sensis.com

Telephonics
815 Broad Hollow Road
Farmingdale, NY 11735
United States
Phone: 631-755-7000
Fax: 631-755-7200
www.telephonics.com

Communications — Aeronautical Mobile Satellite System (AMSS)

Intelast
3400 International Drive NW
Washington, DC 20008-3006
United States
Phone: 202-944-6800
Fax: 202-944-7898
www.intelast.int

Navigation - Wide Area Augmentation System (WAAS)

Raytheon Company
141 Spring Street
Lexington, MA 02421
United States
Phone: 781-862-6600
www.raytheon.com

Local Area Augmentation System (LAAS)

Honeywell Airport Systems
5353 West Bell Road
Glendale, AZ 85308
United States
Phone: 602-436-4808
Fax: 602-561-4777
Email : hilary.king@cashoneywell.com www.cas.honeywell.com

Raytheon Company
141 Spring Street
Lexington, MA 02421
United States
Phone: 781-862-6600
www.raytheon.com

Special Category I (SCAT I)

Honeywell Airport Systems
5353 West Bell Road
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United States
Phone : 602-436-4808
Fax: 602-561-4777

Email : hilary.king@cashoneywell.com www.cas.honevwell.com

Surveillance -Radar

Northrup Grumman Corporation
1840 Century Park E
Los Angeles, CA 90067-2199
United States
Phone: 310-553-6262
www.northgrum.com

Raytheon Company
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Phone: 781-862-6600
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815 Broad Hollow Road
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Fax: 516-755-7010
www.teleohonics.com

Surveillance - Automatic Dependent Surveillance (ADS)

Arinc Incorporated
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Toll Free : 800-633-6882
Fax : 410-266-2329
www.arinc.com

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Lockheed Martin ATM
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www.lmco.com

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Telephonics
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Phone: 516-755-7000
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21. Fencing

Safeguards Technology, Inc.
75 Atlantic Street
Hackensack, NJ 07601
United States
Phone: 201-488-1022
Fax: 201-488-1244
Email : marketing@safeauards.com www.safeguards.com

22. Pavement, Concrete, & Asphalt

CTS Cement Manufacturing Company
11065 Knott Avenue, Suite A
Cypress, CA 90630

United States
Phone: 714-379-8260
Toll Free : 800-929-3030
Fax: 714-379-8270
Email : info@ctscement.com www.ctscement.com

23. Restroom products & suppliers

Bella Bagno, Inc.
5500 W Touhy Avenue, Suite E
Skokie, IL 60077
United States
Phone: 847-673-7328
Fax: 847-673-7338
Email : info@bella-bagno.com www.bella-bagno.com

Brill Hygienic Products, Inc.
601 North Congress Avenue, Building 306
Delray Beach, Fl 33445
United States
Phone: 561-278-5600
Toll Free : 800-330-6696
Fax: 561-272-3542
Email : abrill@brillseat.com or djablow@brillseat.com www.brillseat.com

Koala Corporation
11600 East 53rd Avenue, Unit D
Denver, CO 80239
United States
Phone: 303-574-1000
Fax: 303-574-9000

24. Airport Consultants

Aarotec Infrastucture Group
Phone: 703-573-0500
Email: aarotec@aarotec.com
www.aarotec.com

26. Equipment Integration, Purchasing, Sales & Installation

Aarotec Equipment Company
401 Ponderosa Trail, Suite # 200
Bunker Hill, WV 25413-4323
Phone: 703-573-0500
Email: aarotec@aarotec.com , www.aarotec.com

APPENDICES:

A1 GLOSSARY AND ABBREVIATIONS:

ACI Airports Council International

ACSA Airports Company of South Africa

ADM Aeroportos de Moçambique

ICAO International Civil Aviation Organization

LOS Level of Service (as defined by IATA)

PHP Peak Hour Passenger

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NACALA PHOTOS

1. Nacala Control Tower providing a good view of the Airport
2. Nacala Apron Area with VIP Reception Hall in Background
3. Nacala Apron Area to Right of Preceding Photo
4. Nacala Apron Area to Right of Preceding Photo with Hangars in Background
5. Nacala Midfield View of Taxiway and Runway in the Background
6. Nacala Runway 01
7. Nacala Typical Runway Wear Surface
8. Nacala Runway Showing Patch
9. Nacala Runway Surface Patch along with Alligator Cracks

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Nacala Runway Showing Patch

Nacala Runway Surface Patch along with Alligator Cracks

PEMBA PHOTOS

1. Pemba Airport Airside Terminal View
2. Pemba Airport Landside View
3. Pemba Terminal, Control Tower and ARFF
4. Pemba General Aviation Hangar and Apron Area
5. Pemba ARFF Building
6. Pemba Terminal Departure Lounge while preparing for two Aircraft to Depart
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15. Pemba LAM Pavement Assessment – Tire Damage
16. Pemba LAM Pavement Assessment – Water Accumulation + Raised Aggregate

PEMBA PHOTOS

Pemba Airport Airside Terminal View

Pemba Airport Landside View

Pemba Terminal, Control Tower and ARFF

Pemba General Aviation Hangar and Apron Area

Pemba ARFF Building

Pemba Terminal Departure Lounge while preparing for two Aircraft to Depart

Pemba Commercial Facilities on Landside

Pemba Automobile Rental Office

Pemba Fuel Tanker and Fuel Farm

Pemba Cargo Room

Pemba Airport Runway 35 View

Pemba Airport Runway Surface Wear

Pemba LAM Pavement Assessment – Raised Aggregate – Plus Loss of Binder

Pemba LAM Pavement Assessment – Raised Aggregate

Pemba LAM Pavement Assessment – Tire Damage

Pemba LAM Pavement Assessment – Water Accumulation + Raised Aggregate

Mozambique
2007-11001A vol. 2

Location Map

AIRPORTS OF MOZAMBIQUE

FEASIBILITY STUDY FOR THE EXPANSION and MODERNIZATION OF PEMBA OR NACALA AIRPORT

January 2008

Final Report AutoCAD Drawings

(drawings are not for construction)

Aerial Photo of Vicinity

AEROPORTOS de MOZAMBIQUE
AV. ACORDOS de LUSAKA, NO 3267
MAPUTO, MOZAMBIQUE

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NACALA INTERNATIONAL AIRPORT
NAMPULA PROVINCE, MOZAMBIQUE
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Cargo Building Sections	C 04
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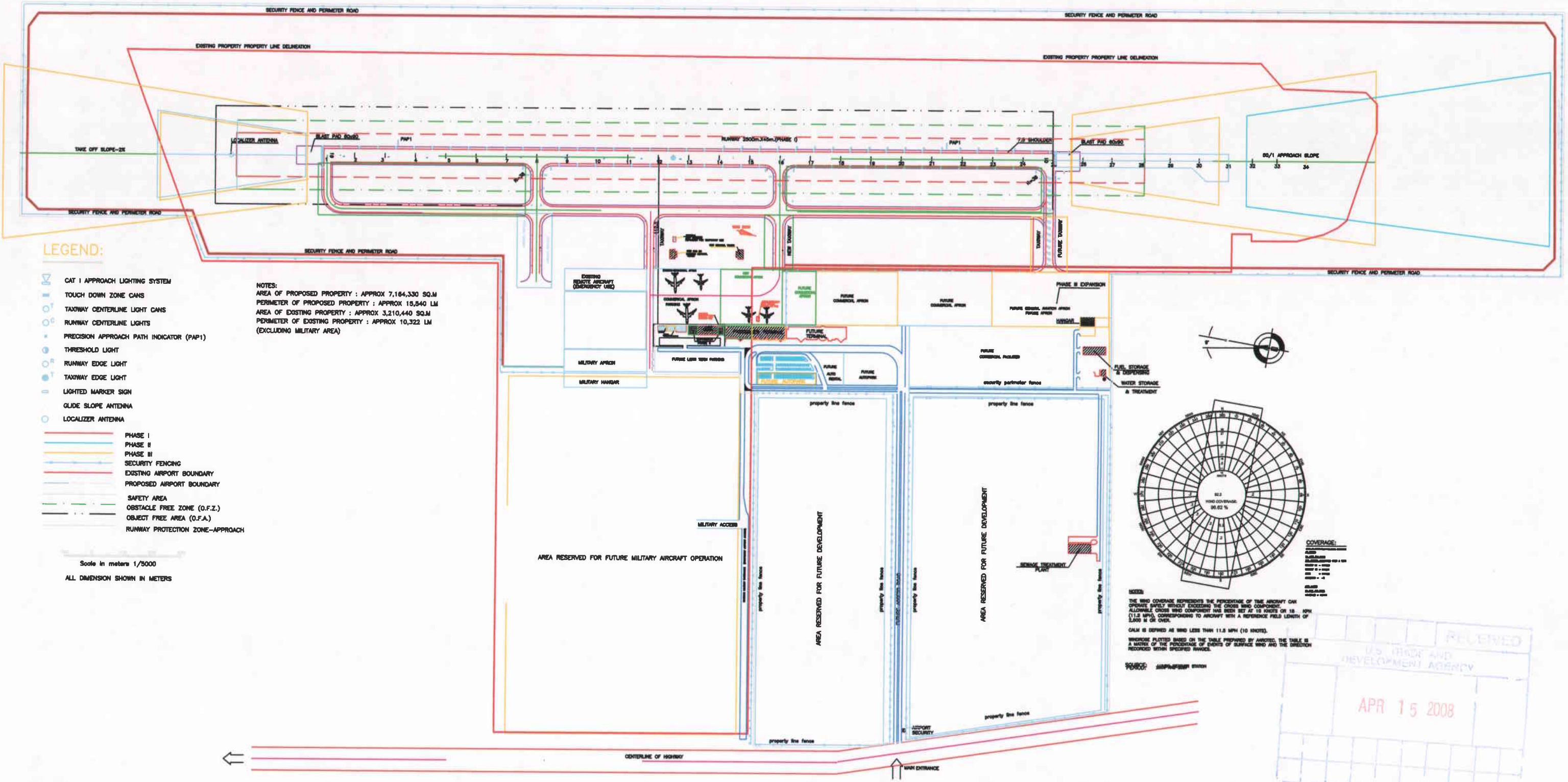
Cargo Building Section B	C 06
Cargo Building Section C	C 07



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DESIGNED	DRAWN	CHECKED	APPROVED	APPROVED
C.M.	ILA	ACY		
	DATE 10/07	DATE 10/07	DATE 12/10	DATE
SCALE	ISSUE DATE	PROJECT No.	SERIES No.	
INDICATED	06/07	8028		

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NAMPULA DISTRICT
MOZAMBIQUE

AIRPORT LAYOUT PLAN

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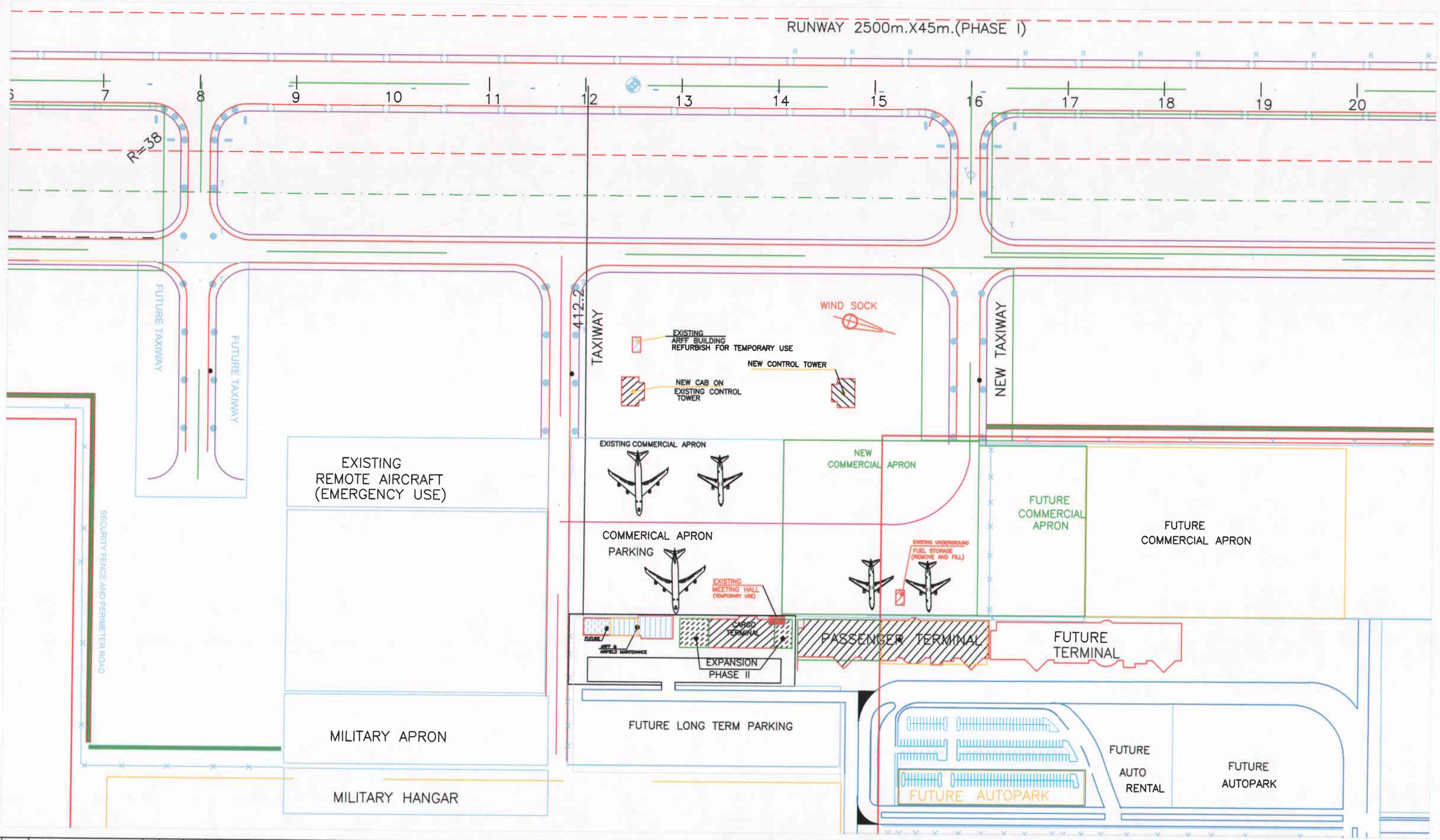

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TERMINAL AREA PLAN

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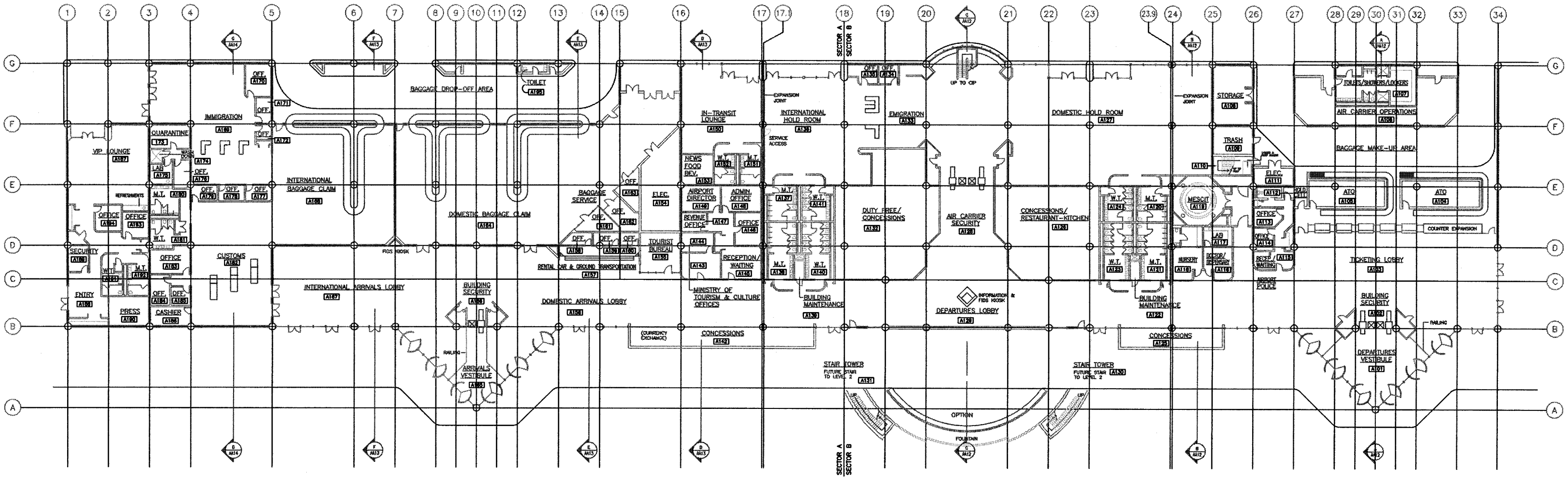

PASSENGER TERMINAL FLOOR PLAN
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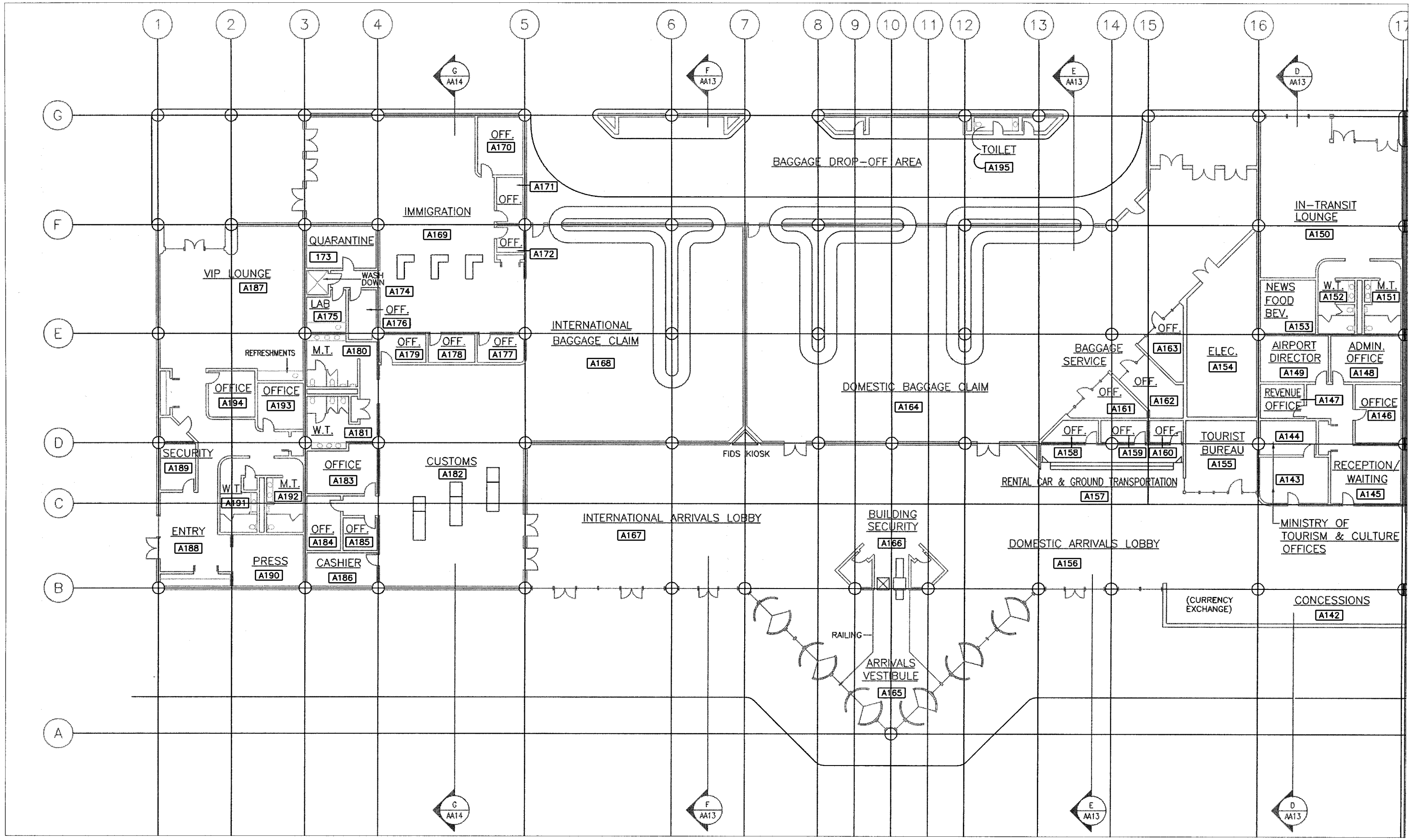
MOZAMBIQUE

TERMINAL FLOOR PLAN
ARRIVAL & DEPARTURE

DRAWING No. NT02



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ARRIVAL AREA
FLOOR PLAN

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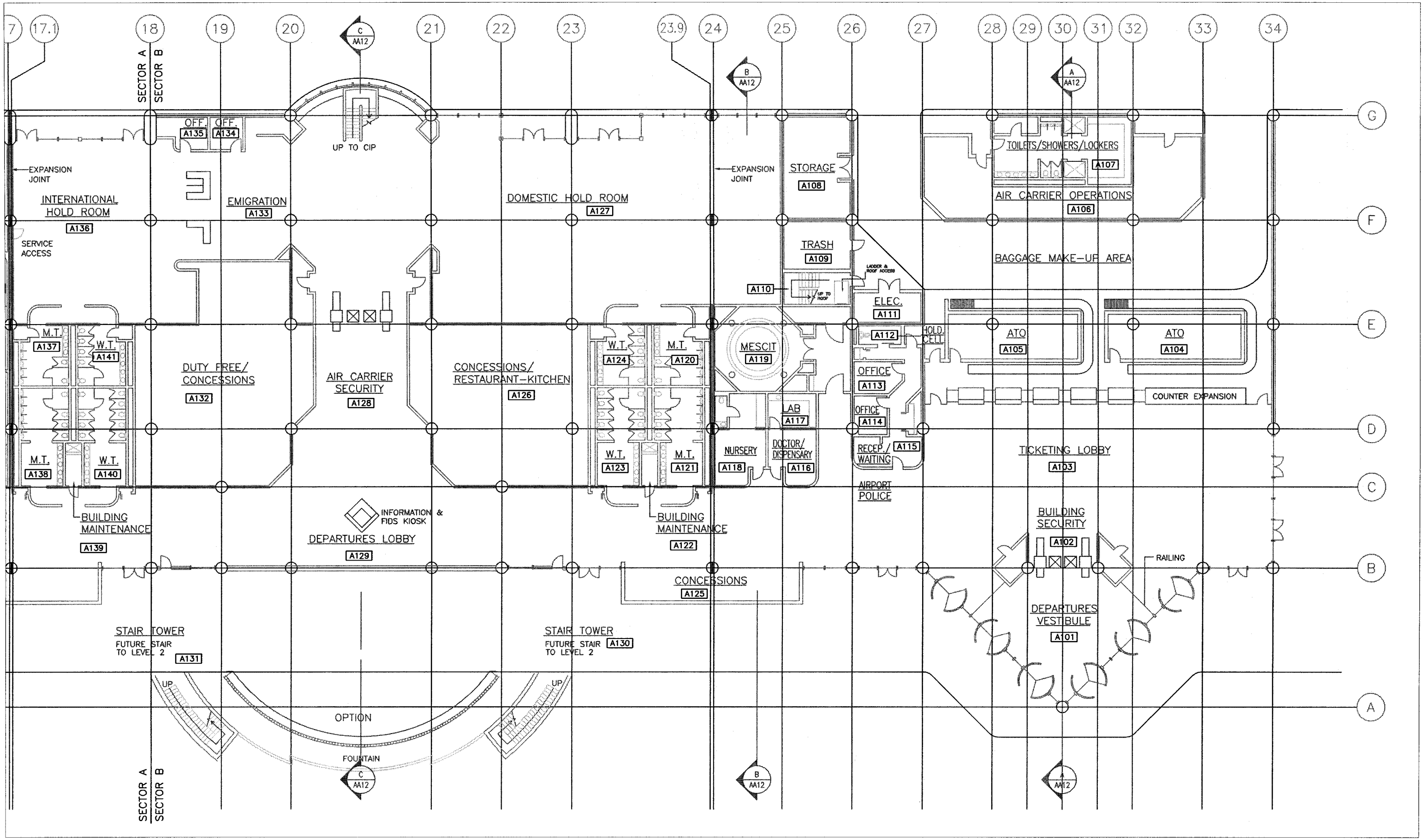

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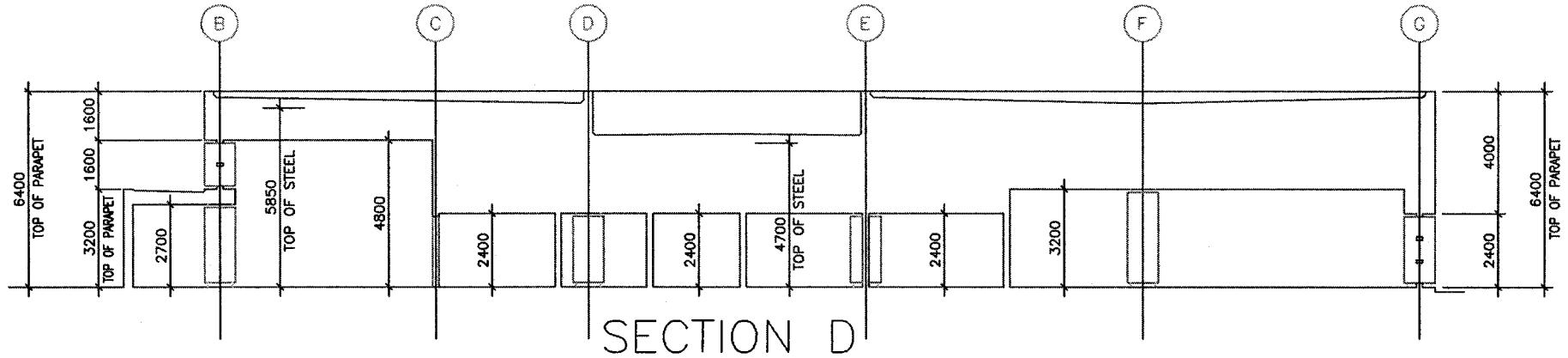
NAMPULA PROVINCE
MOZAMBIQUE

DEPARTURE AREA

DRAWING No. NT02D



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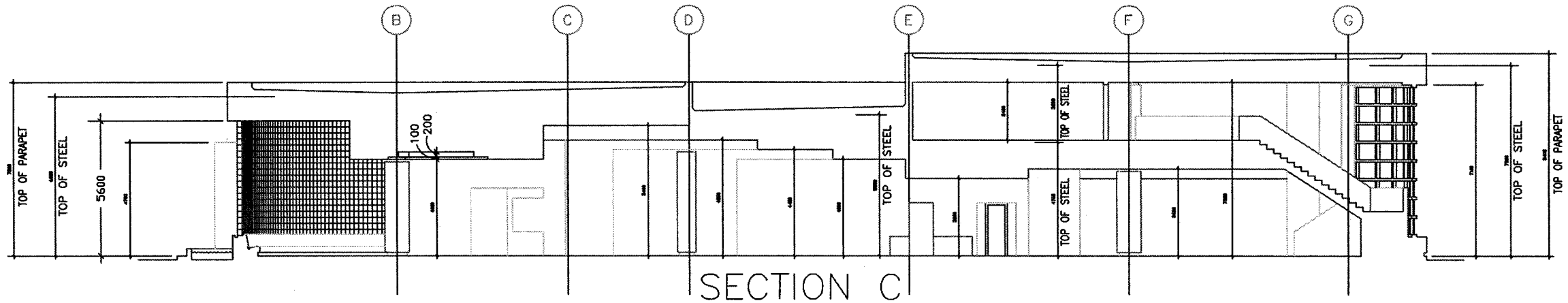

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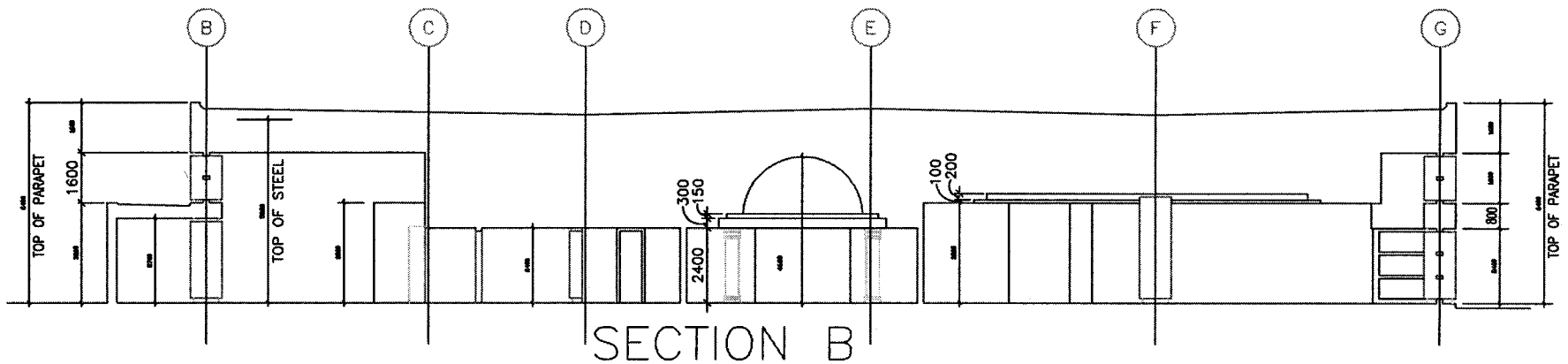

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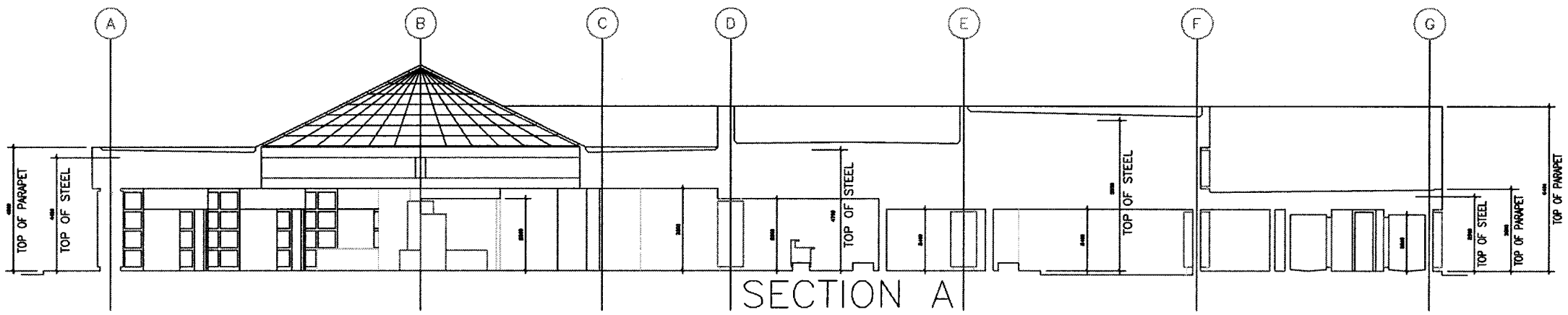


SECTION A

REV. No.	DATE	DESCRIPTION	BY	CHECK	APRO.

AIRPORTS DE MOZAMBIQUE
MAPUTO, MOZAMBIQUE

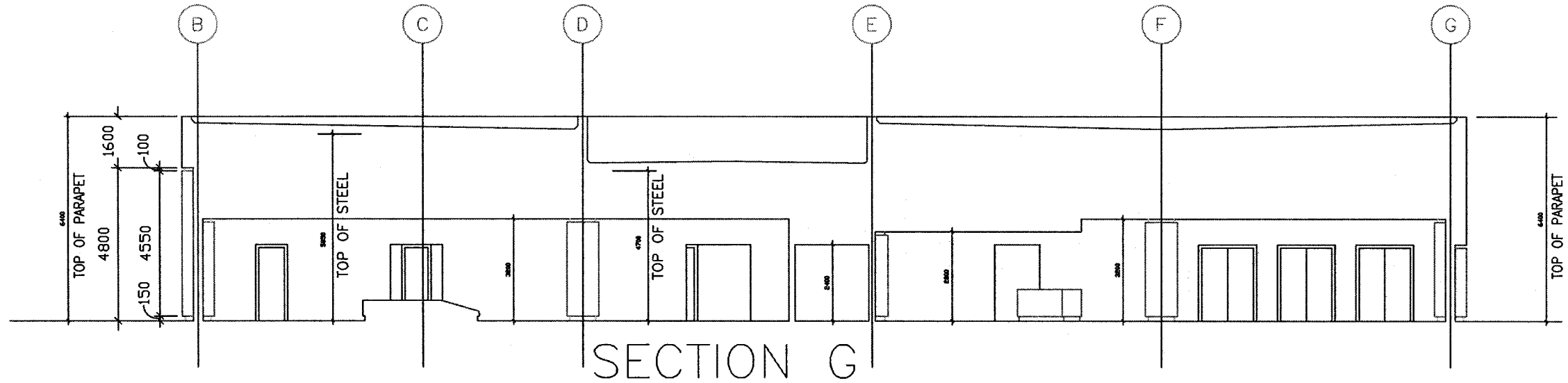
CONSULTANTS: AAROTEC INFRASTRUCTURE GROUP INC.
ALBERT C. YOUNG P.E.
WEB SITE: WWW.AAROTEC.COM
E-MAIL: AAROTEC@AAROTEC.COM

DESIGNED	DRAWN	CHECKED	APPROVED	APPROVED
C.M.	ILA	ACY		
	DATE 10/07	DATE 10/07	DATE 12/10	DATE
SCALE	ISSUE DATE	PROJECT No.	SERIES No.	
INDICATED	06/07	8028		

NACALA INTERNATIONAL AIRPORT
NAMPULA DISTRICT
MOZAMBIQUE

TERMINAL SECTIONS A–B–C–D

DRAWING No. NT03



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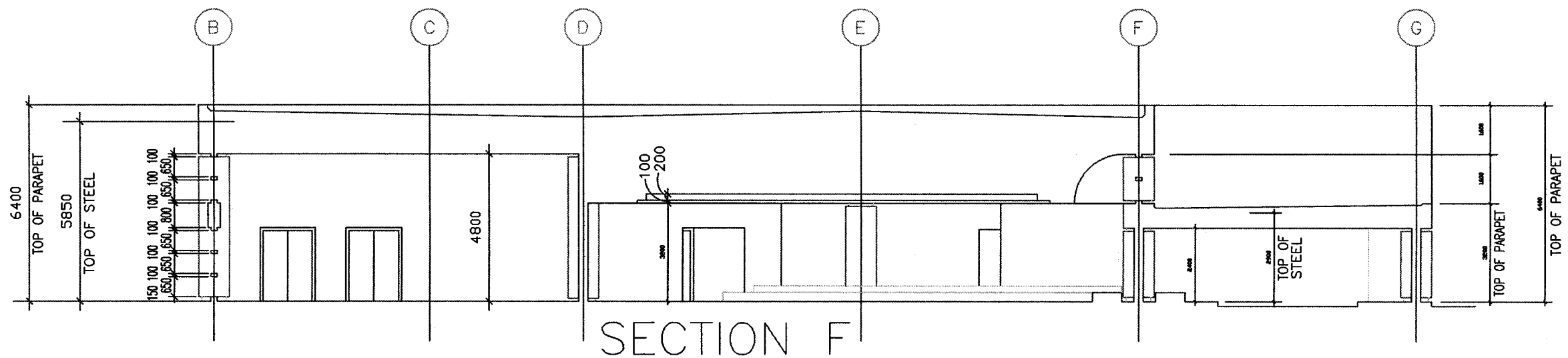

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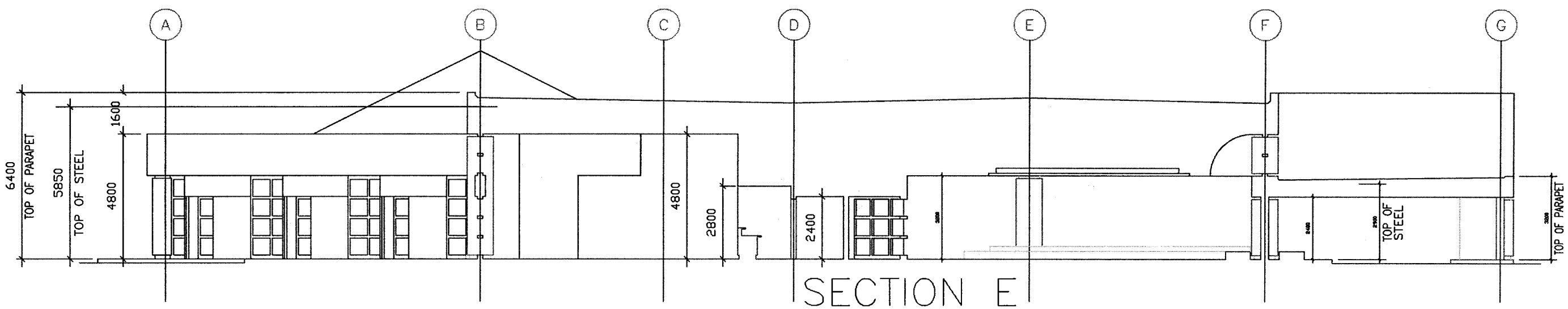

SECTION E

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AIRPORTS DE MOZAMBIQUE
MAPUTO, MOZAMBIQUE

CONSULTANTS: AAROTEC INFRASTRUCTURE GROUP INC.
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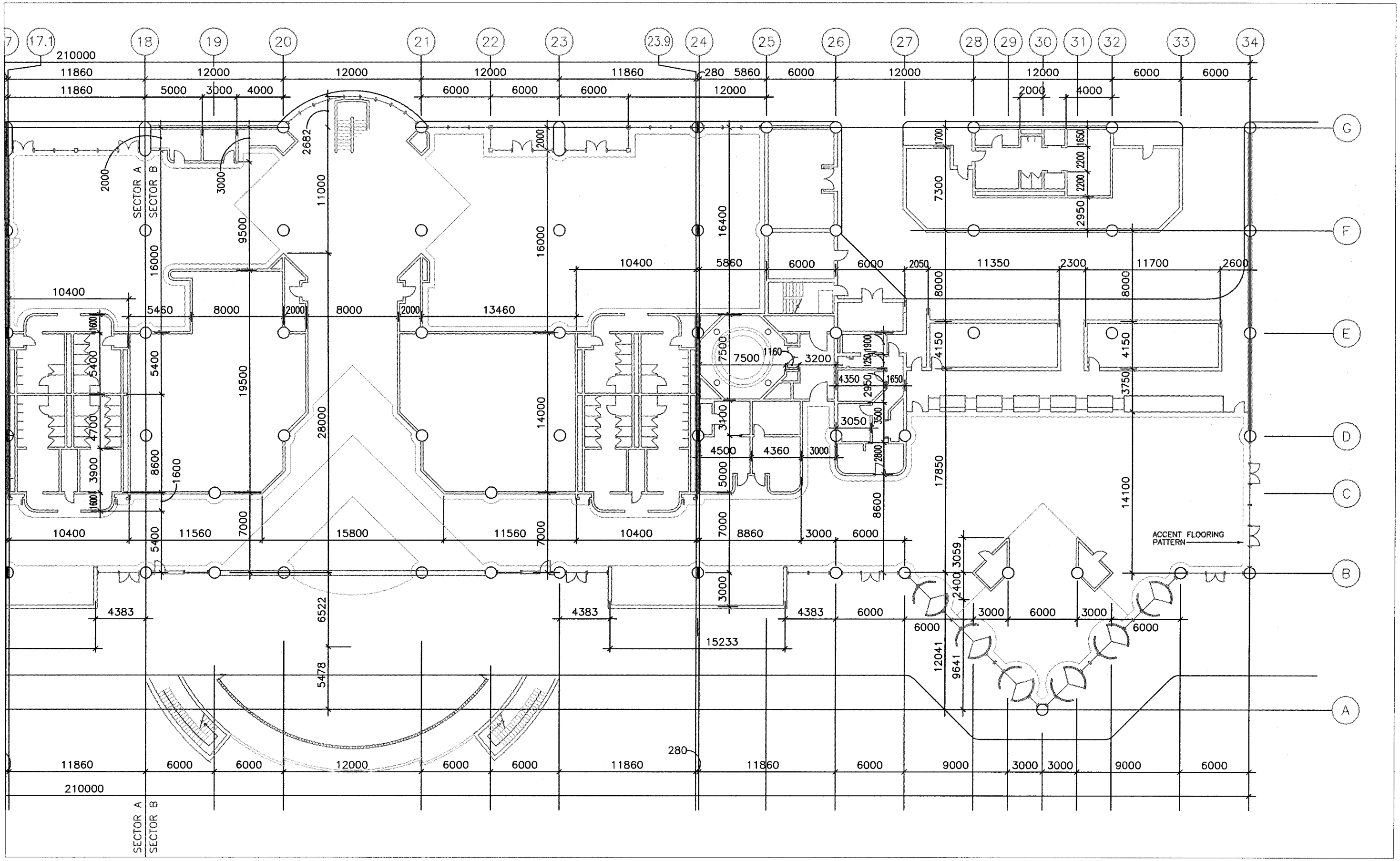
NACALA INTERNATIONAL AIRPORT
NAMPULA DISTRICT
MOZAMBIQUE

TERMINAL SECTIONS E–F–G

DRAWING No. NT04



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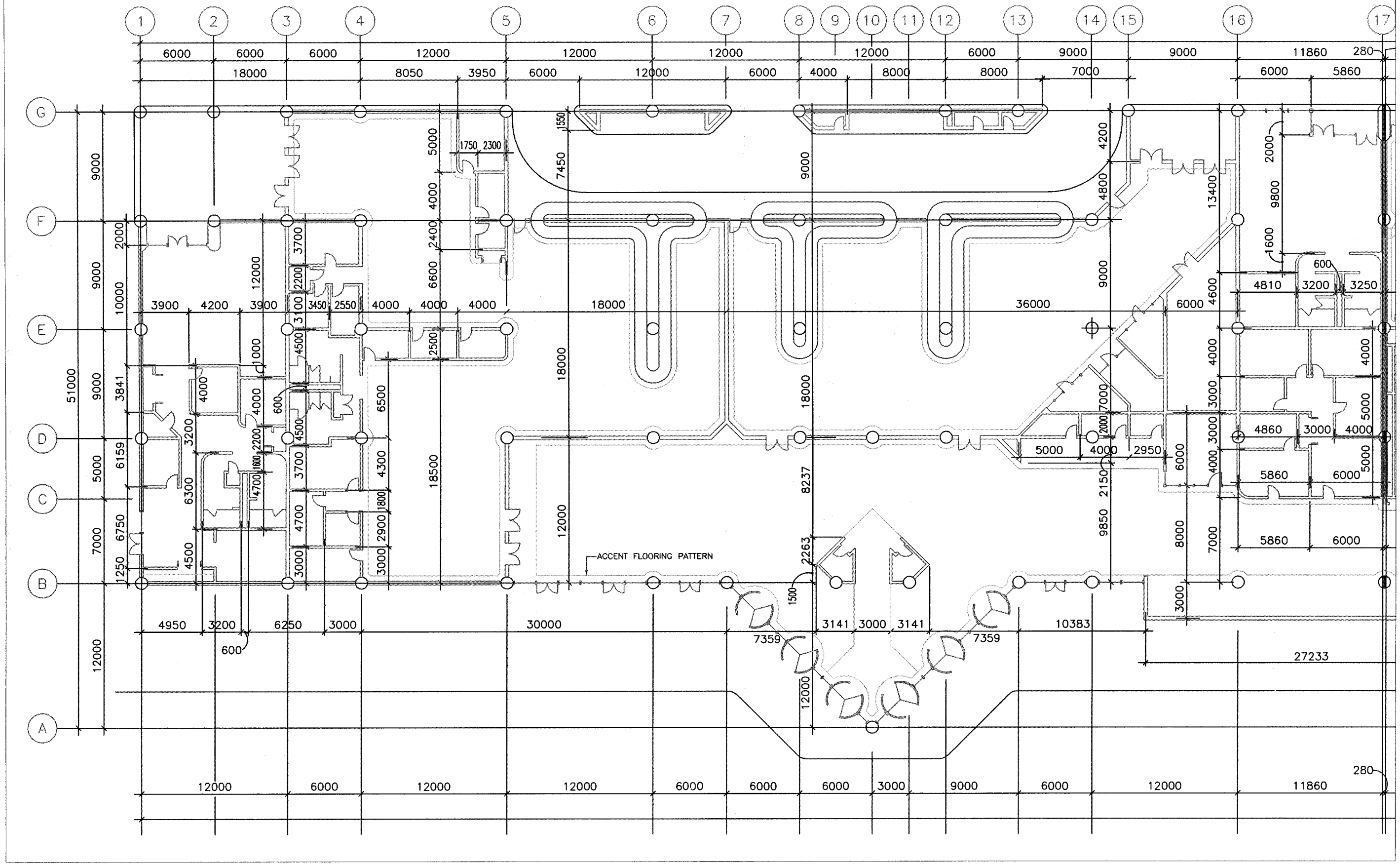
INTERNATIONAL PASSENGER TERMINAL

DEPARTURE AREA FLOOR PLAN WITH DIMENSIONS

DRAWING No. NT 05



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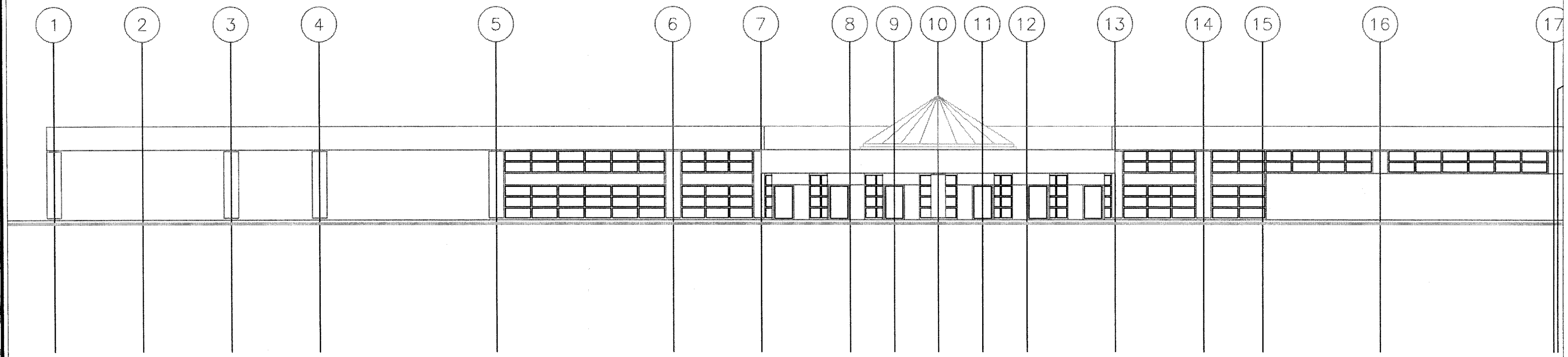
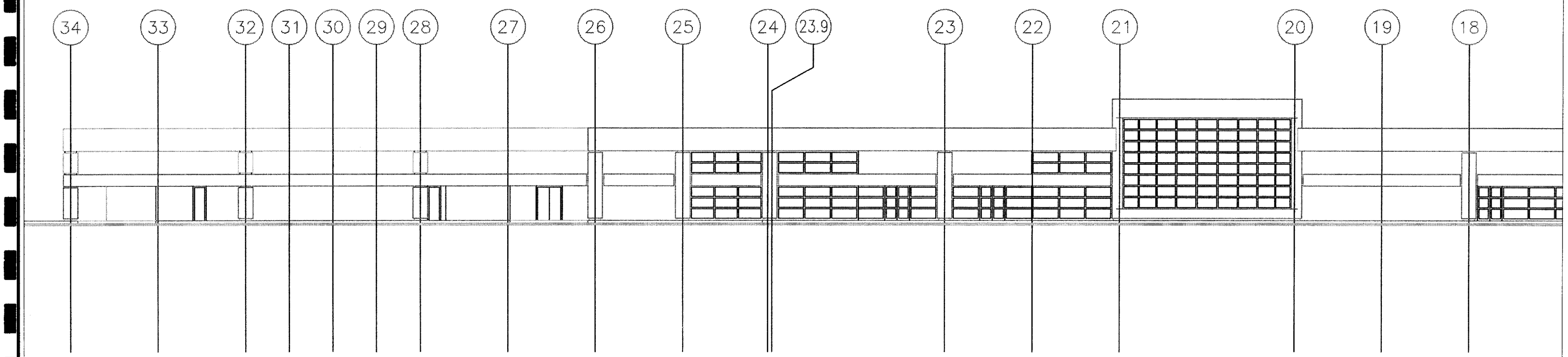
INTERNATIONAL PASSENGER TERMINAL

ARRIVAL AREA FLOOR PLAN WITH DIMENSIONS

DRAWING No. NT 06



LANDSIDE OF ARRIVAL AREA



AIRSIDE OF DEPARTURE AREA

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AIRPORTS DE MOZAMBIQUE
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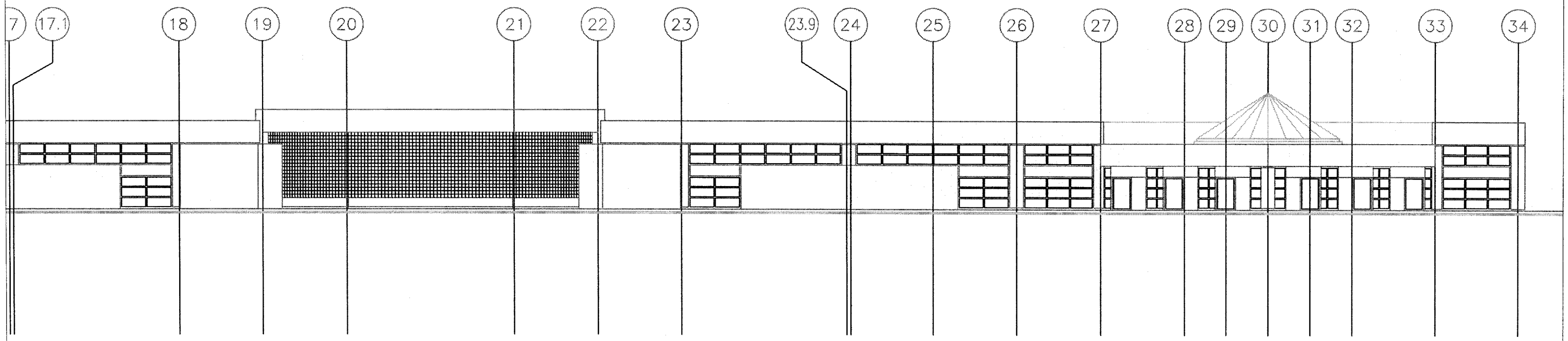
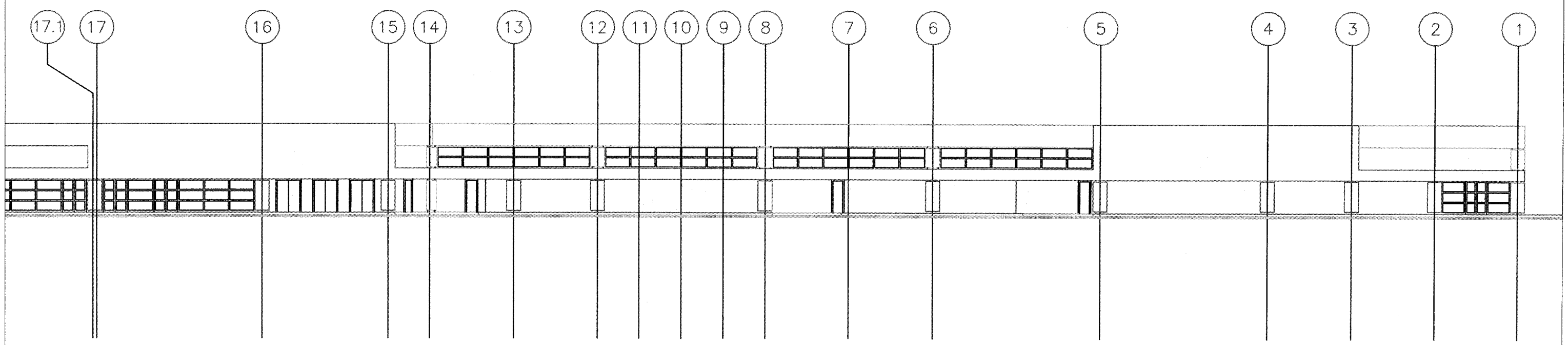
NACALA INTERNATIONAL AIRPORT
NAMPULA DISTRICT
MOZAMBIQUE

TERMINAL ELEVATIONS

DRAWING No. NT07



LANDSIDE OF DEPARTURE AREA



AIRSIDE OF ARRIVAL AREA

REV. No.	DATE	DESCRIPTION	BY	CHECK	APRO.

AIRPORTS DE MOZAMBIQUE
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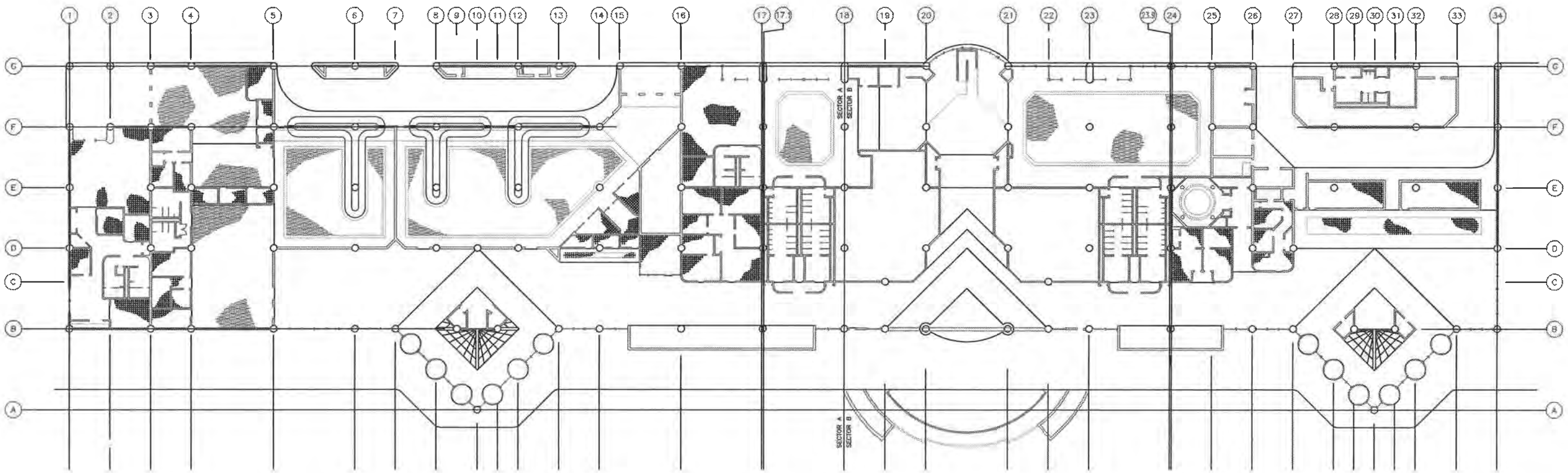
NACALA INTERNATIONAL AIRPORT
NAMPULA DISTRICT
MOZAMBIQUE

TERMINAL ELEVATIONS

DRAWING No. NT08



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AIRPORTS DE MOZAMBIQUE
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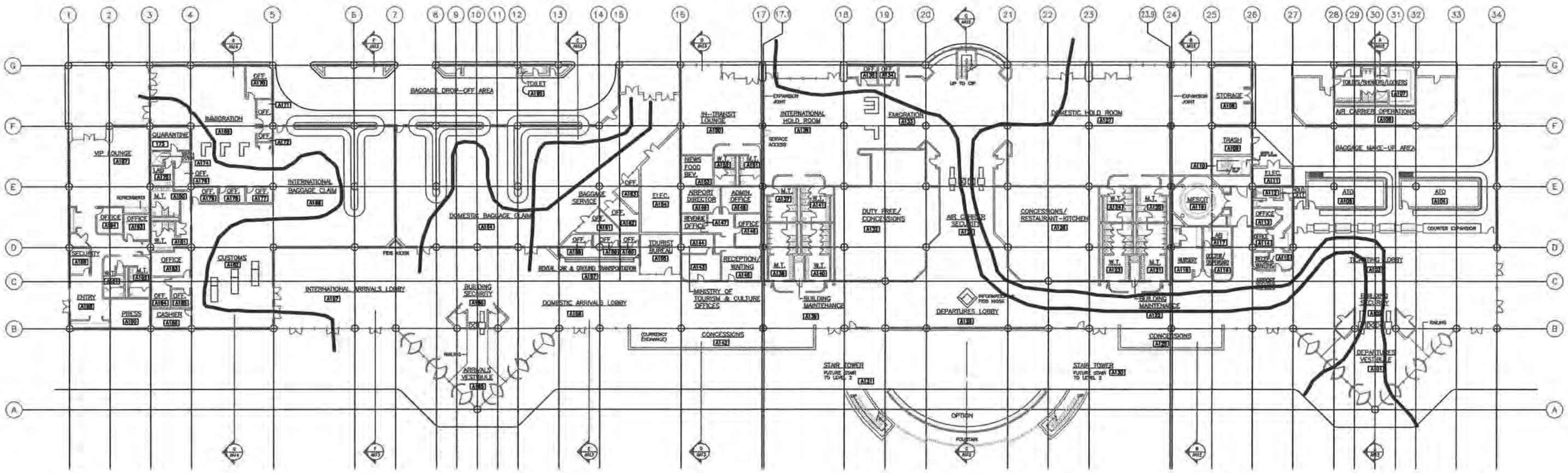
INDICATED	06/07	8028		

NACALA INTERNATIONAL TERMINAL
MOZAMBIQUE

REFLECTIVE CEILING PLAN

DRAWING No. NT09



PASSENGER TERMINAL FLOOR PLAN
SCALE = 1:200

REV. No.	DATE	DESCRIPTION	BY	CHECK	APPRO.

AIRPORTS DE MOZAMBIQUE
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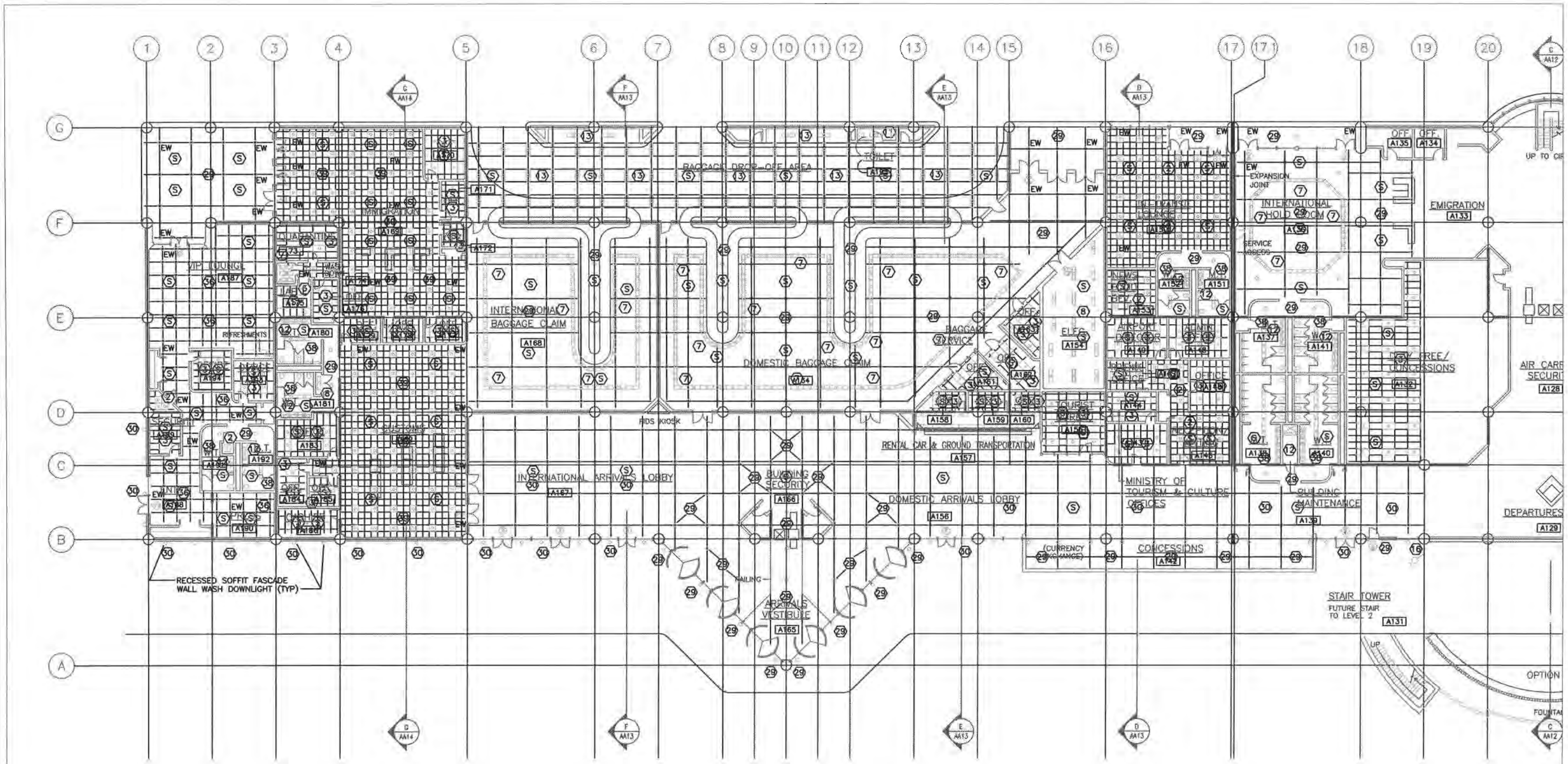
NACALA INTERNATIONAL AIRPORT
NAMPULA DISTRICT
MOZAMBIQUE

TERMINAL FLOOR PLAN
PASSENGER PATH
DRAWING No. NT 10



PASSENGER TERMINAL FLOOR PLAN

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MAPUTO, MOZAMBIQUE

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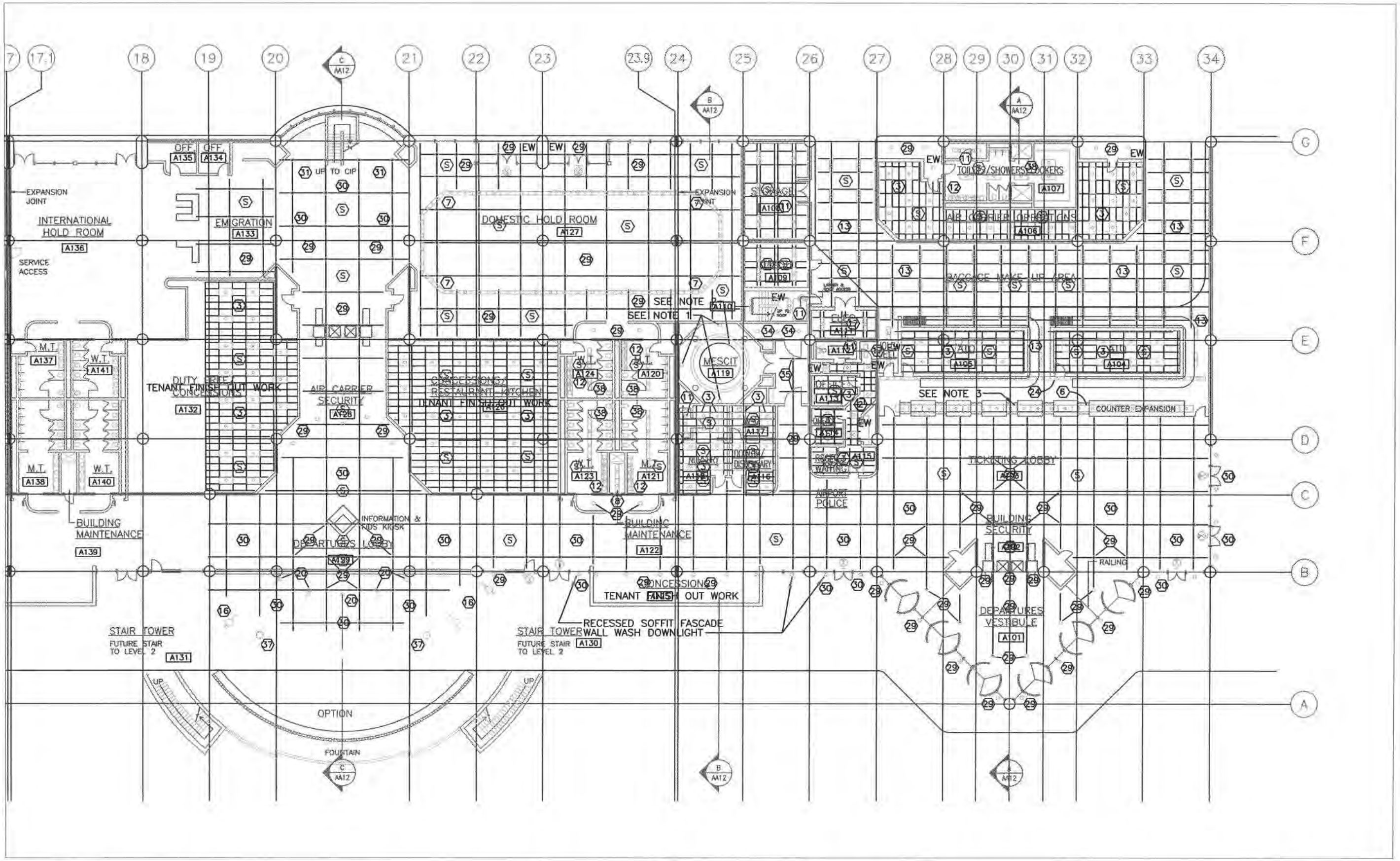
NACALA INTERNATIONAL AIRPORT
NAMPULA PROVINCE
MOZAMBIQUE

LIGHTING PLAN
ARRIVAL AREA

DRAWING No. EA01



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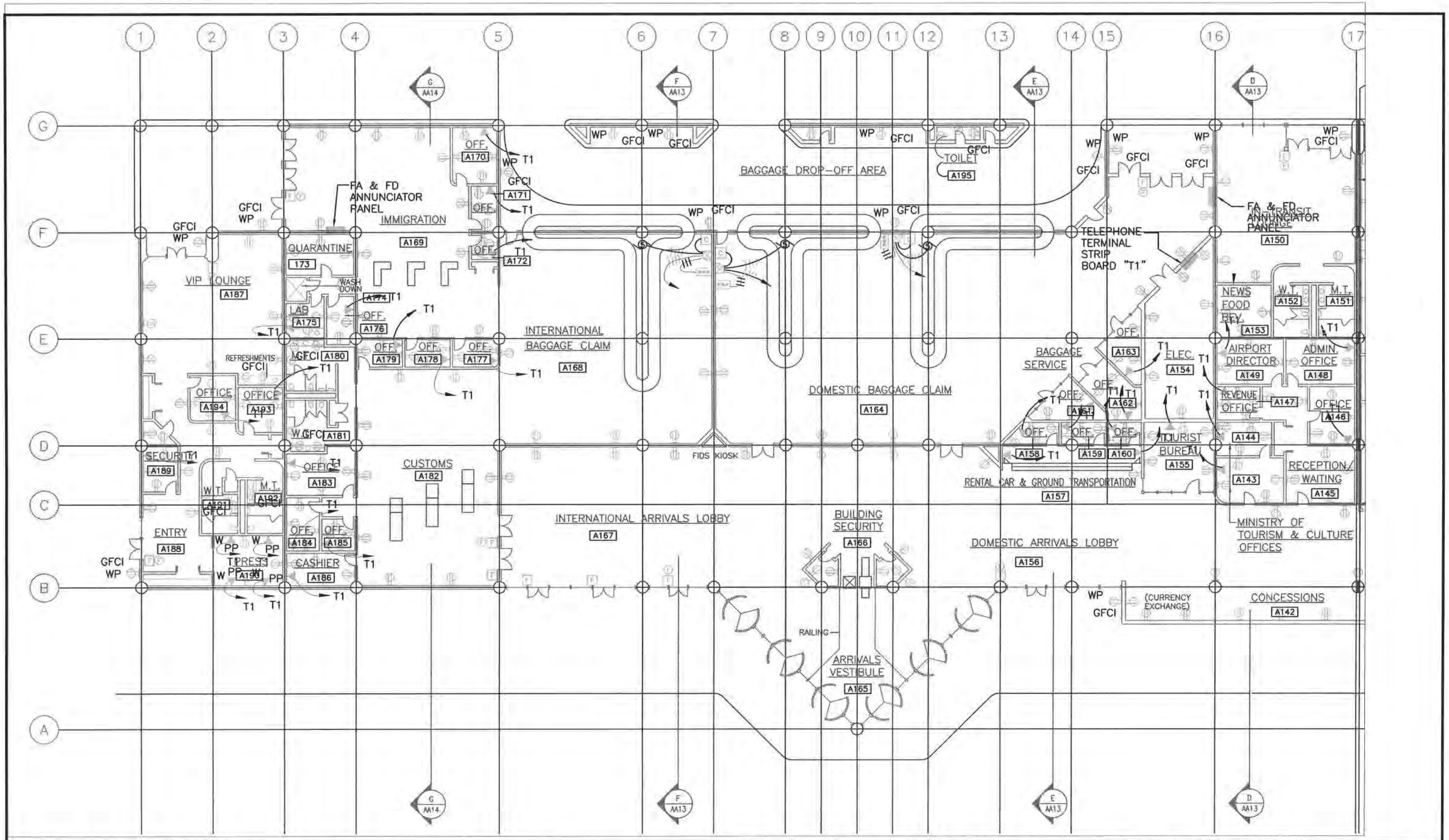
NACALA INTERNATIONAL AIRPORT
NAMPULA PROVINCE
MOZAMBIQUE

LIGHTING PLAN
DEPARTURE AREA

DRAWING No. EA02



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MAPUTO, MOZAMBIQUE

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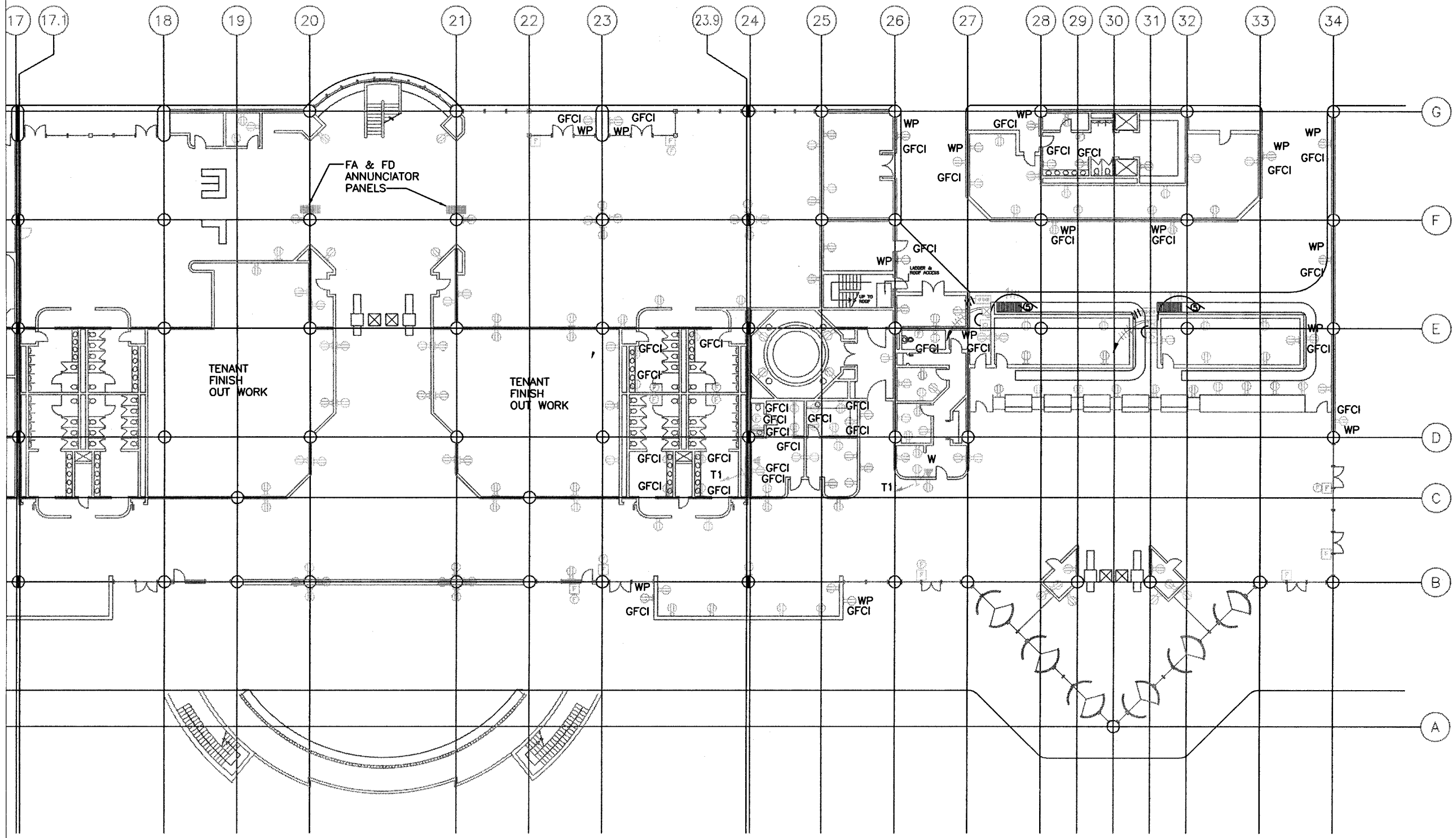
NACALA INTERNATIONAL AIRPORT
NAMPULA PROVINCE
MOZAMBIQUE

TERMINAL POWER PLAN
ARRIVAL AREA
DRAWING No. EA 03

SPECIAL CONCESSIONS/RESTAURANT KITCHEN NOTE

ALL ELECTRICAL PROVISIONS AND CONNECTIONS SHALL BE MADE TO ALL KITCHEN EQUIPMENT. KITCHENS SHALL HAVE FIXED TEMPERATURE AND RATE OF RISE HEAT DETECTORS. ALL KITCHEN AUTOMATIC HOOD EXTINGUISHING DEVICES SHALL BE ANNUNCIATED AT THE F.A. & F.D. ANNUNCIATOR. FIRES IN THE KITCHEN AREA SHALL SHUNT TRIP EITHER MAIN OR BRANCH MOLDED CASE CIRCUIT BREAKERS. FEEDING ELECTRIC ENERGY TO ELECTRIC RESISTIVE HEATING ELEMENTS, SUCH AS ELECTRIC DEEP FAT FRYERS, SKILLETS, GRILLS, OVENS AND STOVES. YOU SHALL USE CLASS "A" WIRING IN THE F.A. & F.D. SYSTEM. ELECTRIC COOKING EQUIPMENT MUST HAVE ITS FEEDER BREAKER SHUNT TRIPPED FROM THE KITCHEN FIRE DETECTION SYSTEM.



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NACALA INTERNATIONAL AIRPORT
NAMPULA PROVINCE
MOZAMBIQUE

TERMINAL POWER PLAN
DEPARTURE AREA

DRAWING No. EA 04

(1) PROVIDE ONE INCOMING PRIMARY MEDIUM VOLTAGE 6 KV PRIMARY ELECTRICAL FEEDER, 6KV RATED SERVICE ENTRANCE COPPER CONDUCTORS WITH ETHYLENE PROPYLENE RUBBER (EPR) INSULATION, EXTRUDED CROSSLINKED POLYETHYLENE (XLP) INSULATION OR UNDERGROUND RESIDENTIAL DISTRIBUTION (URD) INSULATION, THREE (3) SINGLE CONDUCTOR (1/C) OR THREE (3) CONDUCTOR (3/C) TYPE. THE PRIMARY MEDIUM VOLTAGE FEEDER SHALL BE INSTALLED IN ONE OF TWO 10.16 CM (4") I.D. POLYVINYLCHLORIDE (PVC). TYPE II, SCHEDULE 40, HEAVYWALL PLASTIC DUCTS IN A MINIMUM 7.62 CM (3") CONCRETE ENCASEMENT AT A MINIMUM 91.44 CM, (36") BELOW GRADE. THE DUCTBANK SHALL BE INSTALLED FROM THE PRIMARY SIDE OF THE PAD MOUNTED TRANSFORMER TO 3 METERS (9'-10") OUT FROM THE PERIMETER OF THE BUILDING WALL.

(2) PROVIDE THREE 6 KV RATED LIGHTNING ARRESTERS (SURGE-IMPULSE) PROTECTORS.

(3) PROVIDE A LIQUID FILLED POLYDIMETHSILOXANES (SILICON) FLUID COOLED, 750 KVA, 5.75%Z, 3 PHASE, 6KV DELTA PRIMARY -400Y/230V, 3 PHASE-4 WIRE, WYE CONNECTED SECONDARY, PAD MOUNTED TRANSFORMER FOR THE LIGHTING AND POWER REQUIREMENTS.

(4) PROVIDE A LIQUID FILLED POLYDIMETHSILOXANES (SILICON) FLUID COOLED, 1500 KVA, 5.75%Z, 3 PHASE, 6KV DELTA PRIMARY -400Y/230V, 3 PHASE-4 WIRE, WYE CONNECTED SECONDARY, PAD MOUNTED TRANSFORMER FOR THE HEATING, VENTILATING AND AIR CONDITIONING SYSTEM, ELECTRIC HOT WATER AND 100 HP SPRINKLER/STANDPIPE WATER PRESSURE BOOSTER PUMP.

(5) PROVIDE A 550KW (688 KVA @ .8 P.F.) 400Y/230 VOLT, 3 PHASE-4 WIRE, STANDBY EMERGENCY GENERATOR. THE EMERGENCY GENERATOR SHALL HAVE AN ENGINE IN-BLOCK HEATER, A LUBRICATING OIL HEATER AND A BATTERY TRICKLE CHARGER INSTALLED IN A 75DB SOUND INSULATED WEATHERPROOF NEMA 3R ENCLOSURE. IT SHALL COME SUPPLIED WITH A 3,028 LITER, (600 GALLON) DUAL WALL SUBBASE NO. 2 DIESEL OIL FUEL TANK.

(6) PROVIDE A 400Y/230 VOLT, 3 PHASE-4 WIRE, FOUR POLE SWITCHED NEUTRAL, 600 AMP AUTOMATIC TRANSFER SWITCH, 76.2 CM, (30") WIDE BY 44.5 CM, (17-1/2") DEEP BY 1.6 M, (63") HIGH AND 186 KG, (409 LBS), ASCO, CAT. NO. 940360097X28C.

(7) PROVIDE A 1,600 AMP, 400Y/230 VOLT, 3 PHASE-4 WIRE, FULL SOLID NEUTRAL WITH 1/2 GROUND BUS CAPACITY, TOTALLY ENCLOSED WEATHERPROOF, NEMA 3R BUS DUCT, COPPER BUSWAY RATED 55,000 A.I.C. MIN. AT 400 V.A.C. FOR THREE (3) SECONDS OR AT THE CONTRACTORS OPTION HE MAY USE FIVE SETS OF 4-300 MM2, (#500 KCMIL) (3 PHASE WIRE AND 1 NEUTRAL) AND 1-50 MM2 (#1/0 AWG) GREEN GROUND, TYPE "USE" INSULATED CONDUCTORS EACH IN ONE OF 4-8.89 CM, 90.12MM, (3-1/2) GALVANIZED RIGID STEEL CONDUITS (GRSC).

(8) PROVIDE A 3,000 AMP, 400Y/230 VOLT, 3 PHASE-4 WIRE, FULL SOLID NEUTRAL WITH 1/2 GROUND BUS CAPACITY, TOTALLY ENCLOSED WEATHERPROOF, NEMA 3R BUS DUCT, COPPER BUSWAY RATED 110,000 A.I.C. MIN. AT 400 V.A.C. FOR THREE (3) SECONDS OR AT THE CONTRACTORS OPTION HE MAY USE EIGHT SETS OF 4-300 MM2, (#500 KCMIL) (3 PHASE WIRES AND 1 NEUTRAL) AND 1-50 MM2 (#1/0 AWG) GREEN GROUND, TYPE "USE" INSULATED CONDUCTORS EACH IN ONE OR 8-6.80 CM, 90.12 MM, (3-1/2) GALVANIZED RIGID STEEL CONDUITS (GRSC).

(9) PROVIDE A 2.54 CM, 25.5 MM (1") GALVANIZED RIGID STEEL CONDUIT (GRSC).

(10) PROVIDE A 400Y/230 VOLT, 3 PHASE-4 WIRE, 1600 AMP, COPPER BUS, SECONDARY ELECTRICAL LOW VOLTAGE SWITCHBOARD (MDP), BRACED FOR A MINIMUM OF 65,000 A.I.C. AT 400 V.A.C.

(11) PROVIDE A 400Y/230 VOLT, 3 PHASE-4 WIRE, 3200 AMP, COPPER BUS, SECONDARY ELECTRICAL LOW VOLTAGE SWITCHGEAR (MDS), BRACED FOR A MINIMUM OF 65,000 A.I.C. AT 400 V.A.C.

(12) PROVIDE AN EMERGENCY POWER DISTRIBUTION PANEL "DPE" 400Y/230 VOLT, 3 PHASE-4 WIRE, S/N, W/GND., 3 POLE, 1,600 AMP MAIN LUG ONLY (MLO) BRACED FOR A MINIMUM OF 65,000 A.I.C., AT 400 V.A.C.

(13) PROVIDE A LIGHTING AND POWER EMERGENCY PANEL "LPE" 400Y/230 VOLT, 3 PHASE-4 WIRE, S/N, W/GND., 3 POLE, 600 AMP, MAIN CIRCUIT BREAKER (MCB) SET TO TRIP AT 600 AMPS, BRACED FOR A MINIMUM OF 65,000 A.I.C. AT 400 V.A.C.

(14) PROVIDE A 3.82 METER (12'-6") WIDE BY 5.6 METER (18'-4") LONG 15.25 CM (6") DEEP, TRANSFORMER PAD CONFORMING TO THE REQUIREMENTS OF THE TWO TRANSFORMERS INSTALLED.

(15) PROVIDE A 3.66 METER (12'-0") WIDE BY 6.13 METER (20'-2") LONG BY 15.25 CM (6") DEEP DIESEL ENGINE GENERATOR PAD CONFORMING TO THE REQUIREMENTS OF THE GENERATOR SET.

(16) PROVIDE A 1.9 CM, (3/4") DIAMETER BY 3.05 METERS, (10'-0") LONG, COPPER CLAD GROUND ROD, TYPICAL OF 3 MINIMUM.

(17) PROVIDE AN EXOTHERMIC CADWELD, TYPICAL OF 19.

(18) PROVIDE 50 MM2, (#1/0 AWG) SOFT DRAWN BARE COPPER GROUND CONDUCTOR.

(19) PROVIDE A .95 CM, (3/8") THICK BY 2.54 CM, (1") WIDE COPPER EQUIPMENT GROUND BUS AND ANCHOR TO THE WALL WITH 10.16 CM (4") INSULATED STAND OFFS INSTALLED AT 61 CM, (24 INCHES) ON CENTER.

(20) CONNECT A 500 MM2 (#1/0 AWG) GROUND CONDUCTOR TO THE MAIN DISTRIBUTION SWITCHBOARDS AND MAIN DISTRIBUTION SWITCHGEARS GROUND BUS.

(21) PROVIDE 50 MM2 (1/0 AWG) BARE COPPER GROUND CONDUCTOR IN A 5CM, 51MM, (2") I.D., POLYVINYLCHLORIDE (PVC), TYPE II, SCHEDULE 40, HEAVYWALL PLASTIC DUCT.

(22) PROVIDE A RECESSED JUNCTION BOX FOR THE 220 VOLT, 1500 WATT DIESEL ENGINE IN BLOCK WATER JACKET HEATER.

(23) PROVIDE A RECESSED JUNCTION BOX FOR THE 230 VOLT, 150 WATT DIESEL ENGINE LUBRICATING OIL HEATER.

(24) PROVIDE A RECESSED JUNCTION BOX FOR THE DIESEL ENGINE BATTERY TRICKLE CHARGER.

(25) PROVIDE A RECESSED JUNCTION BOX FOR THE AUTOMATIC TRANSFER SWITCH CONTROL CIRCUIT TO AUTOMATICALLY START THE DIESEL ENGINE GENERATOR.

(26) EACH OF THE FOUR JUNCTION BOXES ARE RECESSED INTO THE DIESEL ENGINE EMERGENCY GENERATOR CONCRETE PAD.

(27) PROVIDE A COMBINATION MAGNETIC MOTOR STARTER WITH INTEGRAL NON-FUSED DISCONNECT OF THE APPARENT REDUCED VOLTAGE, CLOSED TRANSITION, STAR DELTA (WYE DELTA TYPE) WITH AN AUTOMATIC TRANSFER SWITCH FOR NORMAL UTILITY/EMERGENCY POWER SELECTION. FLOOR MOUNTED.

(28) PROVIDE A COMBINATION MAGNETIC MOTOR STARTER WITH INTEGRAL NON-FUSED DISCONNECT OF THE APPARENT REDUCED VOLTAGE, CLOSED TRANSITION, STAR DELTA (WYE DELTA TYPE) MOUNTING HEIGHT 4'-6" AFF.

(29) ALL OVERHEAD ELECTRICAL RACEWAYS SHALL BE RUN AS HIGH AS POSSIBLE IN OPEN SPACES OR IN DROPPED CEILING CAVITY SPACES AND SHALL BE HELD AS TIGHT AS POSSIBLE TO THE CEILING SLAB OR STRUCTURE.

(30) PROVIDE A COMBINATION MAGNETIC MOTOR STARTER WITH HANDS-OFF-AUTOMATIC (H.O.A.) SELECTOR SWITCH AND INTEGRAL NON-FUSED DISCONNECT SWITCH 60 AMP, 3 POLE, 600 VOLT, NON-FUSED DISCONNECT IN A NEMA 1 MOTOR STARTER ENCLOSURE WITH A NEMA SIZE 0 MOTOR STARTER.

(31) PROVIDE A COMBINATION MAGNETIC MOTOR STARTER WITH HANDS-OFF-AUTOMATIC (H.O.A.) SELECTOR SWITCH AND INTEGRAL NON-FUSED DISCONNECT SWITCH 60 AMP, 3 POLE, 600 VOLT, NON-FUSED DISCONNECT IN A NEMA 1 MOTOR STARTER ENCLOSURE WITH A NEMA SIZE 1 MOTOR STARTER.

(32) PROVIDE A COMBINATION MAGNETIC MOTOR STARTER WITH HANDS-OFF-AUTOMATIC (H.O.A.) SELECTOR SWITCH AND INTEGRAL NON-FUSED DISCONNECT SWITCH 100 AMP, 3 POLE, 600 VOLT, NON-FUSED DISCONNECT IN A NEMA 1 MOTOR STARTER ENCLOSURE WITH A NEMA SIZE 2 MOTOR STARTER.

(33) PROVIDE A 30 AMP, 3 POLE, 600 VOLT, NON-FUSED DISCONNECT IN A NEMA 1 ENCLOSURE.

(34) PROVIDE A 60 AMP, 3 POLE, 600 VOLT, NON-FUSED DISCONNECT IN A NEMA 1 ENCLOSURE.

(35) PROVIDE A 100 AMP, 3 POLE, 600 VOLT, FUSED DISCONNECT SWITCH, FUSED AT _____ AMPS, IN A WEATHERPROOF NEMA 3R ENCLOSURE.

(36) PROVIDE A 200 AMP, 3 POLE, 600 VOLT, FUSED DISCONNECT SWITCH, FUSED AT _____ AMPS, IN A WEATHERPROOF NEMA 3R ENCLOSURE.

(37) PROVIDE A CAPACITIVE POWER FACTOR CORRECTIVE DEVICE (TYPICAL).

(38) ELECTRIC SQUIRREL CAGE INDUCTION MOTOR, 400 VOLTS, 3 PHASE, 50 HERTZ (TYPICAL).

(39) PROVIDE A MOTOR CONTROL CENTER (MCC), NEMA CLASS II, WIRING CLASS "C" (TYPE C), 400Y/230 VOLTS, THREE (3) PHASE, FOUR (4) WIRE, SOLID NEUTRAL (S/N) WITH GROUND, 600 AMP HORIZONTAL COPPER BUS, 300 AMP VERTICAL COPPER BUS BRACED FOR 65,000 A.I.C., MIN. AT 400 V.A.C.

(40) PROVIDE 3-95 MM2 (#3/0 AWG) AND 1-16 MM2 (#6 AWG) GREEN GROUND EACH IN ONE OF TWO 5.08 CM, 51 MM, (2") GALVANIZED RIGID STEEL CONDUIT (GRSC).

(41) PROVIDE TWO SETS OF 3-95 MM2 (#3/0 AWG) AND 1-16 MM2 (#6 AWG) GREEN GROUND EACH IN ONE OF TWO 5.08 CM, 51 MM, (2") GALVANIZED RIGID STEEL CONDUIT (GRSC).

(42) PROVIDE A FIRST FLOOR LIGHTING AND POWER PANEL "LPA" 400Y/230 VOLT, 3 PHASE-4 WIRE, S/N, W/GND., 3 POLE, 400 AMP MAIN LUG ONLY (MLO), BRACED FOR A MINIMUM OF 22,000 A.I.C., AT 400 V.A.C.

(43) PROVIDE A FIRST FLOOR LIGHTING AND POWER PANEL "LPB" 400Y/230 VOLT, 3 PHASE-4 WIRE, S/N, W/GND., 3 POLE, 400 AMP MAIN LUG ONLY (MLO), BRACED FOR A MINIMUM OF 22,000 A.I.C. AT 400 V.A.C.

(44) PROVIDE A FIRST FLOOR LIGHTING AND POWER PANEL "LPC" 400Y/230 VOLT, 3 PHASE-4 WIRE, S/N, W/GND., 3 POLE, 400 AMP MAIN LUG ONLY (MLO), BRACED FOR A MINIMUM OF 22,000 A.I.C. AT 400 V.A.C.

(45) PROVIDE A FIRST FLOOR LIGHTING AND POWER PANEL "LPD" 400Y/230 VOLT, 3 PHASE-4 WIRE, S/N, W/GND., 3 POLE, 400 AMP MAIN LUG ONLY (MLO), BRACED FOR A MINIMUM OF 22,000 A.I.C. AT 400 V.A.C.

(46) PROVIDE ONE SET OF 4-300 MM2 (#500 MCM) (3 PHASE WIRES AND 1 NEUTRAL) AND 1-500 MM, (#1 AWG) GREEN GROUND EACH IN 8.89 CM, 88.9 MM, (3-1/2") GALVANIZED RIGID STEEL CONDUIT (GRSC).

(47) PROVIDE TWO SETS OF 4-185 MM2 (#350 MCM) (3 PHASE WIRES AND 1 NEUTRAL) AND 1-35 MM, (#2 AWG) GREEN GROUND EACH IN ONE OF TWO 7.62 CM, 51 MM, (3") GALVANIZED RIGID STEEL CONDUIT (GRSC).

SURGE ARRESTER NOTES:

LIGHTING ARRESTERS ARE RELATIVELY INEXPENSIVE DEVICES COMMONLY CALLED "SURGE SUPPRESSORS", "TRANSIENT SUPPRESSORS" OR "IMPULSE SUPPRESSORS". PROTECTION AGAINST IMPULSES IS GENERALLY PROVIDED IN THREE STEPS:

1. PRIMARY PROTECTION IS ON THE HIGH VOLTAGE (35,000Y/230,207 VOLT AND 6000Y/3464 VOLT) SIDE OF THE TRANSFORMER IN THE FORM OF LIGHTNING ARRESTERS. THIS PRIMARY PROTECTION IS PROVIDED BY THE CUSTOMER WHEN PURCHASING PRIMARY POWER.

2. SECONDARY PROTECTION SHALL BE PROVIDED ON THE IMMEDIATE SECONDARY SIDE OF THE TRANSFORMER TO FURTHER REDUCE IMPULSE LEVELS; AND

3. TERTIARY PROTECTION (FACILITY SECONDARY SURGE PROTECTION) CALLS FOR SUPPRESSION DEVICES TO BE PLACED AT OR CLOSE TO THE TRANSMITTER, RECEIVER, TELECOMMUNICATION, SECURITY AND COMPUTER EQUIPMENT AS POSSIBLE SO AS TO LIMIT THE IMPULSES TO ACCEPTABLE VOLTAGE LEVELS. THESE BUILDING/FACILITY SECONDARY SURGE PROTECTION DEVICES SHALL BE CONNECTED TO THE TRANSMITTER, RECEIVER, TELECOMMUNICATION, SECURITY AND COMPUTER POWER PANELBOARDS.

DISTRIBUTION CLASS SUPPRESSORS ARE THE LEAST EXPENSIVE, AND HAVE THE SHORTEST USEFUL LIVES. INTERMEDIATE CLASS ARRESTERS ARE MORE COSTLY, BUT HAVE LONGER LIFESPANS. STATION CLASS ARRESTERS ARE THE MOST EXPENSIVE AND HAVE THE GREATEST LONGEVITY. STATION CLASS ARRESTERS ARE THEREFORE RECOMMENDED FOR USE IN THIS FACILITY. LOWER COST SUPPRESSORS GENERALLY HAVE TOO SHORT A SERVICE LIFE (GUARANTEED NUMBER OF OPERATIONS) TO JUSTIFY THEIR USE. ALSO, THESE DEVICES, WHILE REDUCING IMPULSE VOLTAGE LEVELS, GENERALLY DO NOT PROVIDE COMPLETE PROTECTION TO TRANSMITTER, RECEIVER, TELECOMMUNICATIONS, SECURITY OR COMPUTER EQUIPMENT, IN ADDITION THEY PROVIDE NO PROTECTION FROM BROWNOUTS AND BLACKOUTS.

PASSENGER TERMINAL POWER ONE-LINE RISER DIAGRAM

NOT TO SCALE

REV. No.	DATE	DESCRIPTION	BY	CHECK	APRO.

AIRPORTS DE MOZAMBIQUE
MAPUTO, MOZAMBIQUE

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C.H.	ILA	ACY		
	DATE 10/07	DATE 10/07	DATE 12/10	DATE
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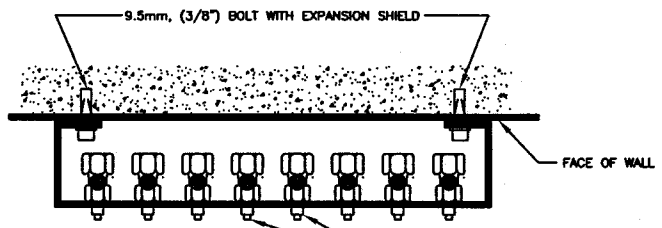
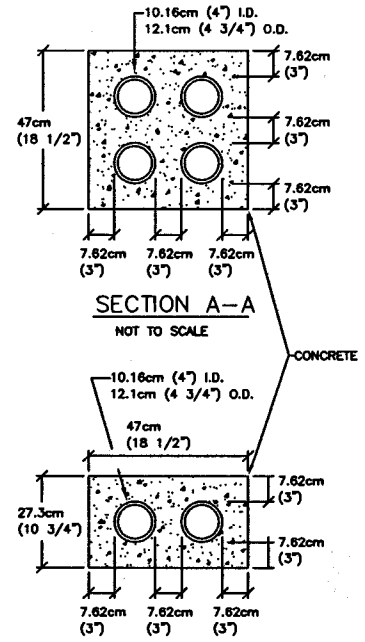
NACALA INTERNATIONAL TERMINAL
NAMPULA PROVINCE
MOZAMBIQUE

POWER - ONE LINE RISER DIAGRAM

DRAWING No. EA07

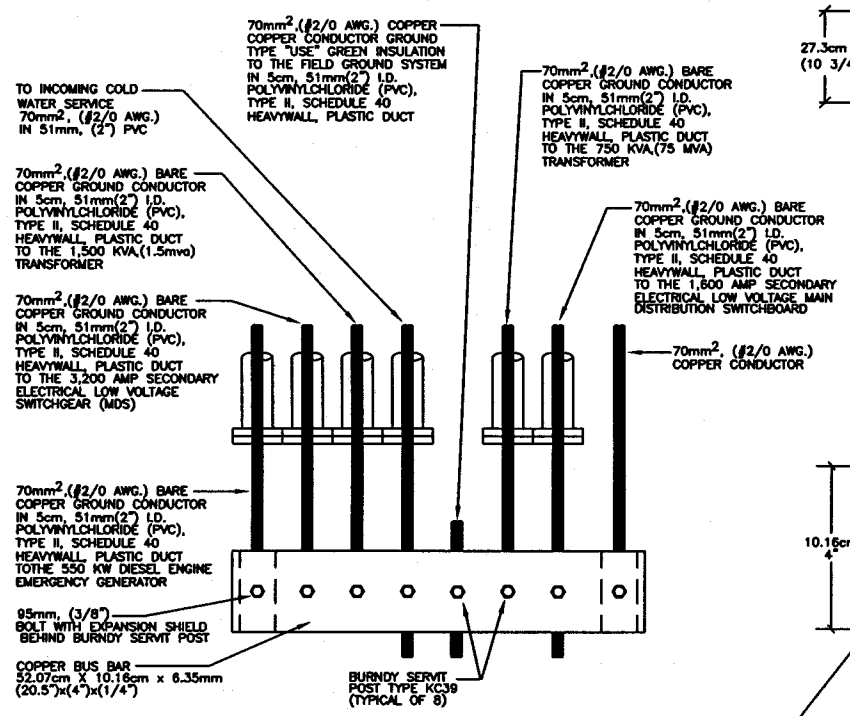


TOP VIEW
NOT TO SCALE

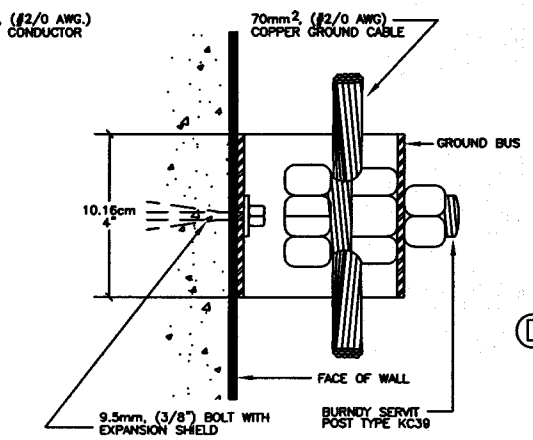


SECTION A–A
NOT TO SCALE

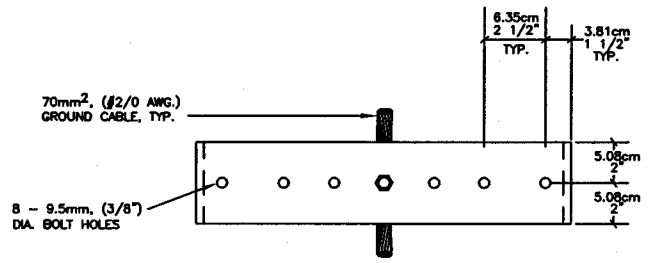
SECTION B–B
NOT TO SCALE



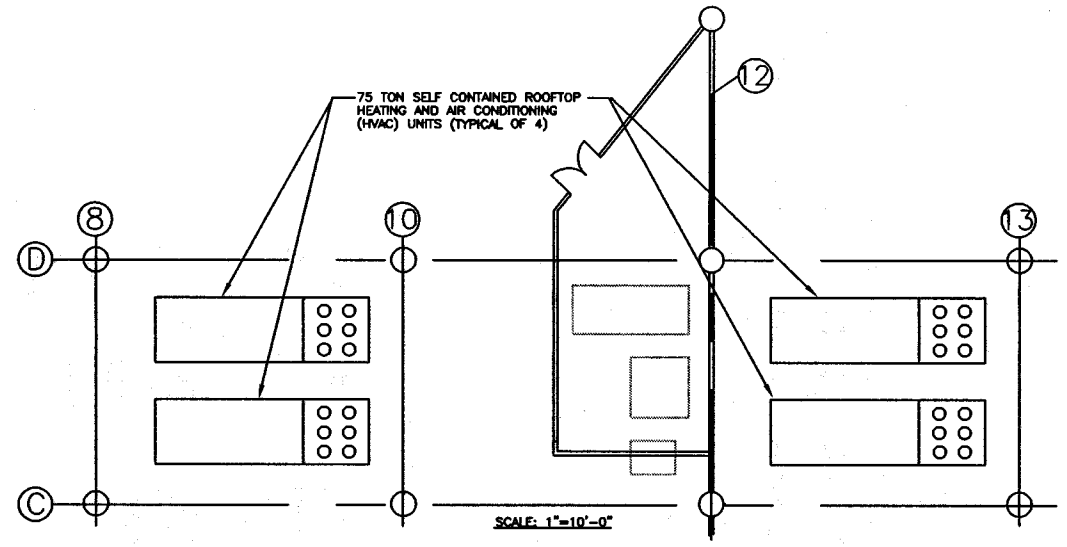
SECONDARY ELECTRIC SERVICE GROUND BUS
NOT TO SCALE

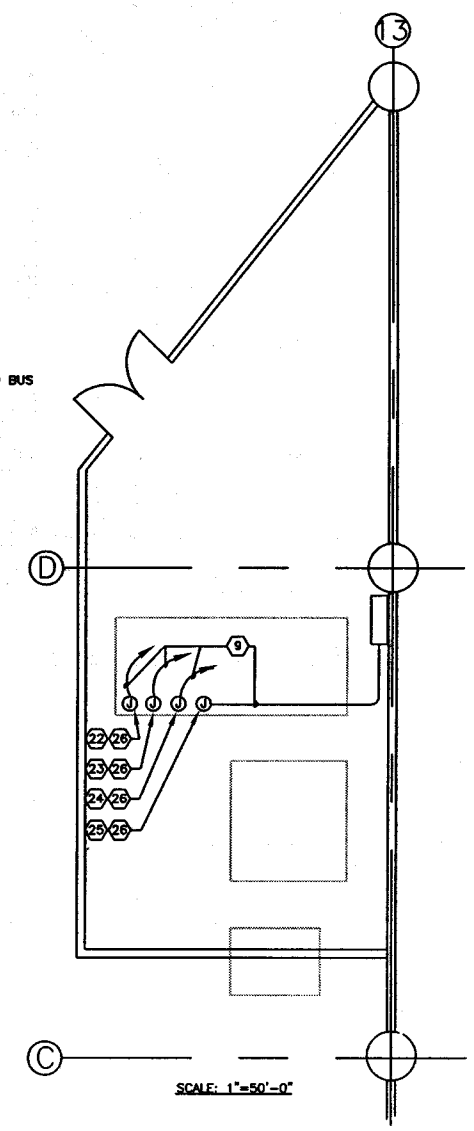


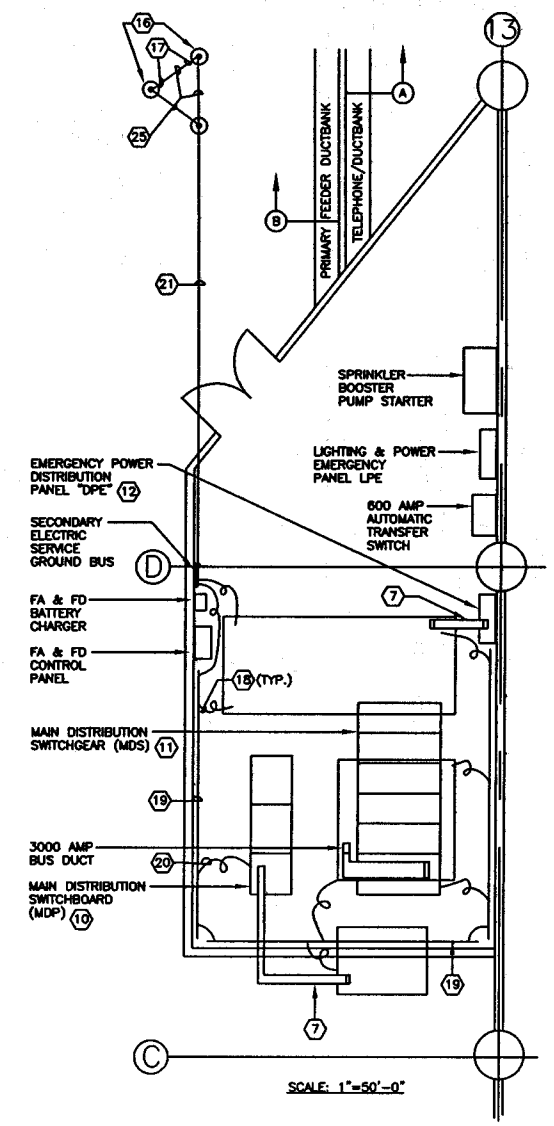
SIDE VIEW
NOT TO SCALE



FRONT VIEW
GROUND BUS DETAIL
NOT TO SCALE







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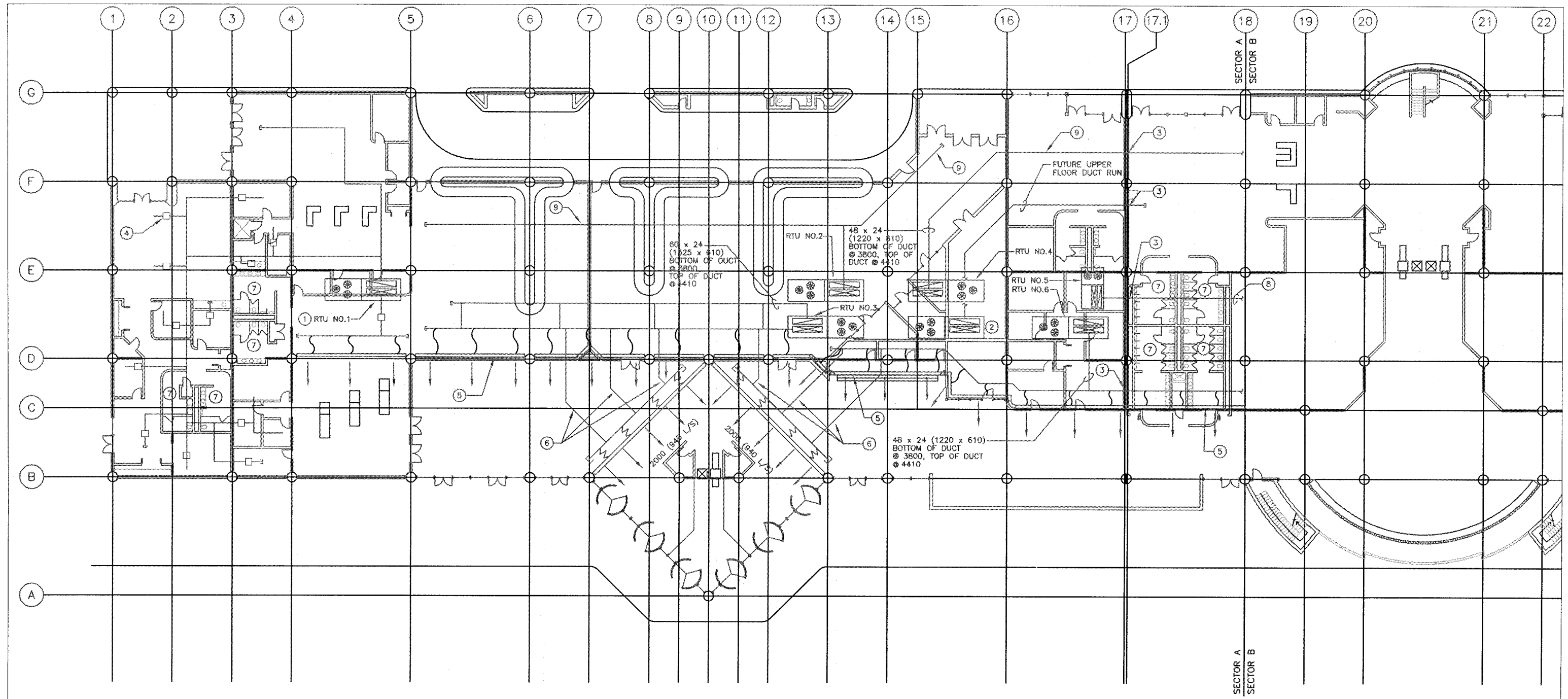
NACALA INTERNATIONAL TERMINAL
NAMPULA PROVINCE
MOZAMBIQUE

EQUIPMENT LAYOUT PLAN
AND POWER DISTRIBUTION PLAN

DRAWING No. EA 08



PASSENGER TERMINAL FLOOR PLAN

SCALE = 1:200 SECTOR A

DESIGN NOTES:

1. ALL ROOF TOP UNITS ARE LOCATED IN EQUIPMENT WELLS ON ROOF
2. FUTURE UPPER FLOOR LEVEL ROOF TOP UNIT LOCATION.
3. PROVIDE FLEXIBLE 12" LONG DUCT CONNECTION AT COLUMN LINES 17 AND 24, TO PROVIDE FOR DUCT EXPANSION ACROSS BUILDING EXPANSION JOINT.
4. TYPICAL VARIABLE AIR VOL. TERMINAL UNIT.
5. LINEAR SLOT DIFFUSER IN BULKHEAD. (TYPICAL)
6. 10" (250) DIAMETER FLEXIBLE DUCTWORK.
7. PROVIDE TOILET EXHAUST SYSTEM FOR THIS AREA.
8. PROVIDE VARIABLE AIR VOLUME TERMINAL UNITS, BRANCH DUCTS AND AIR SUPPLY DIFFUSERS, AS NECESSARY, IN DISTRIBUTION DUCTWORK SYSTEM.
9. PROVIDE BRANCH DUCTS AND AIR DISTRIBUTION SUPPLY DIFFUSERS AS NECESSARY IN DISTRIBUTION DUCTWORK SYSTEM.

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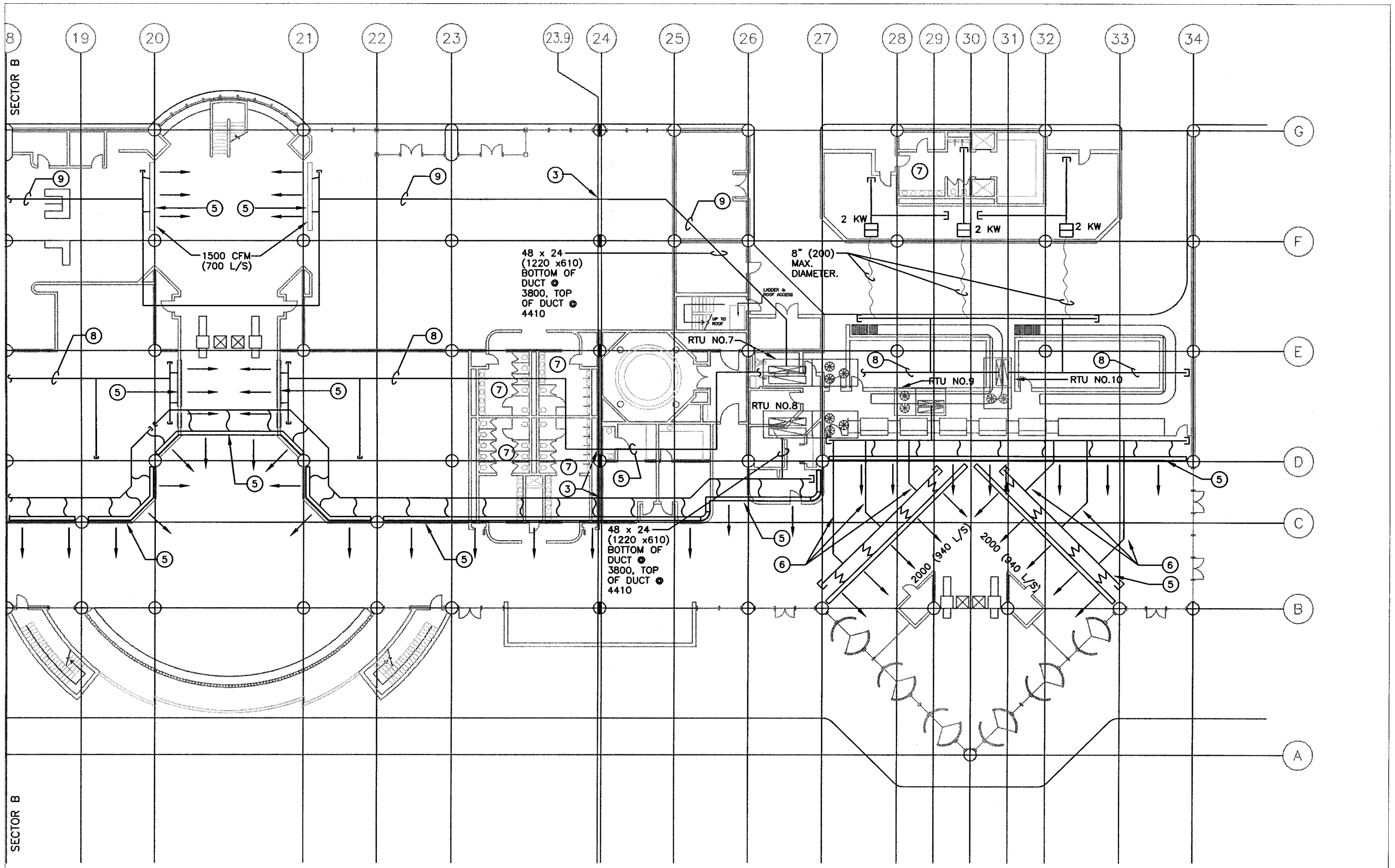
NACALA INTERNATIONAL AIRPORT
NAMPULA PROVINCE
MOZAMBIQUE

TERMINAL MECHANICAL PLAN
ARRIVAL AREA

DRAWING No. MA 01



PASSENGER TERMINAL FLOOR PLAN

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NACALA INTERNATIONAL AIRPORT
NAMPULA PROVINCE
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TERMINAL MECHANICAL PLAN
ARRIVAL AREA

DRAWING No. MA 02

A. DEAD LOADS:

1. DEAD LOADS HAVE BEEN CALCULATED BASED ON THE FOLLOWING ASSUMED UNIT WEIGHTS:
   a. BUILT-UP ROOFING: 0.25 kPa
   b. LIGHTWEIGHT CONCRETE TOPPING SLAB: 0.75 kPa
c. MECHANICAL/ELECTRICAL/LIGHTING: 0.25 kPa
d. CONCRETE ROOF SLAB/METAL DECK: 1.85 kPa
e. CEILING: 0.15 kPa
f. EXTERIOR WALLS 2.15 kPa

B. LIVE LOADS:

1. LIVE LOADS HAVE BEEN CALCULATED BASED ON THE FOLLOWING ASSUMED UNIFORM LOADS:
   OFFICE LOADS: 4.75 kPa

C. SNOW LOADS:

1. 0.80 kPa FOR FLAT ROOFS. SNOW LOADS HAVE BEEN CALCULATED IN ACCORDANCE WITH THE REQUIREMENTS OF THE 1991 UNIFORM BUILDING CODE, SECTION 2343.0.
2. IN ADDITION TO THE FLAT ROOF SNOW LOADS STATED ABOVE, A SNOW LOAD PROVISION FOR DRIFTING SNOW HAS BEEN PROVIDED FOR IN ACCORDANCE WITH THE REQUIREMENTS OF THE 1991 UNIFORM BUILDING CODE, SECTION 2347.0. DRIFTING SNOW SHALL BE CONSIDERED TO BE APPLIED AS A LINEARLY INCREASING SURCHARGE LOAD WITH:

ZONE 1: AIR SIDE, AT LOW ROOF
MAXIMUM SURCHARGE: 3.55 kPa
MINIMUM SURCHARGE: 0.00 kPa
DRIFT WIDTH: 3.9 m

ZONE 2: LAND SIDE, AT LOBBY
MAXIMUM SURCHARGE: 2.85 kPa
MINIMUM SURCHARGE: 0.00 kPa
DRIFT WIDTH: 1.55 m

D. WIND LOADS:

1. THE BUILDING HAS BEEN DESIGNED FOR A WIND LOAD IN ACCORDANCE WITH THE AMERICAN NATIONAL STANDARD, SECTION 6.0, FOR:
   BASIC WIND SPEED: V = 120 kM/HR
   BUILDING CATEGORY: I
   EXPOSURE CATEGORY: C

2. WIND LOADS SHALL BE CONSIDERED TO BE REVERSIBLE AND SHALL BE APPLIED NORMAL TO ALL SURFACES AS FOLLOWS. PLUS AND MINUS SIGNS SIGNIFY PRESSURES ACTING TOWARD AND AWAY FROM SURFACES, RESPECTIVELY.

a. WALLS:
   WINDWARD:
   0.0 – 9.1m 0.80 kPa

b. LEEWARD:
   0.0 – 9.1m –0.50 kPa

c. SIDE WALLS:
   0.0 – 9.1m –0.70 kPa

d. ROOF:
   0.0 – 9.1m –0.70 kPa

E. SEISMIC LOADS:

1. THE BUILDING STRUCTURE HAS BEEN DESIGNED FOR A SEISMIC LOAD IN ACCORDANCE WITH THE 1991 UNIFORM BUILDING CODE SECTION 2334.0, FOR:
   SEISMIC ZONE FACTOR 2A:
   Z=0.15
   OCCUPANCY CATEGORY: I
   SOIL CHARACTERISTIC SITE COEFFICIENT: S=1.5
   LATERAL LOAD RESISTING SYSTEM COEFFICIENT:
   LATERAL DIRECTION: RW=8
   LONGITUDINAL DIRECTION: RW=6

2. SEISMIC LOADS SHALL BE CONSIDERED TO BE REVERSIBLE AND SHALL BE APPLIED TO THE LATERAL FORCE RESISTING ELEMENTS AS FOLLOWS:
3. LATERAL FORCE, V: 0.0645W
4. W SHALL INCLUDE THE TOTAL TRIBUTARY DEAD LOAD OF ALL BUILDING ELEMENTS AND ALL PORTIONS OF SNOW LOAD EXCEEDING A UNIFORM SNOW LOAD OF 1.44 kPa.
5. THE BUILDING ELEMENTS HAVE BEEN DESIGNED FOR A SEISMIC LOAD IN ACCORDANCE WITH THE 1991 UNIFORM BUILDING CODE SECTION 2336.0, FOR:
   SEISMIC ZONE FACTOR, ZONE 2A: Z=0.15
   OCCUPANCY CATEGORY: I

6. SEISMIC LOADS SHALL BE CONSIDERED TO BE REVERSIBLE AND SHALL BE APPLIED TO THE BUILDING ELEMENTS AS FOLLOWS:
   LATERAL FORCE, V:0.14Wp

7. Wp SHALL INCLUDE THE TOTAL UNIT WEIGHT OF THE BUILDING ELEMENT UNDER CONSIDERATION.

F. LOAD COMBINATIONS:

1. ALL LOADS NOTED ABOVE SHALL BE CONSIDERED TO ACT IN THE FOLLOWING COMBINATIONS, WHICHEVER PRODUCE THE MOST UNFAVORABLE EFFECT IN THE BUILDING, FOUNDATION, OR STRUCTURAL MEMBER BEING CONSIDERED.
   a. DEAD LOAD
b. DEAD LOAD + LIVE LOAD + SNOW LOAD
c. DEAD LOAD + WIND LOAD
d. DEAD LOAD + SEISMIC LOAD
e. DEAD LOAD + LIVE LOAD + SNOW LOAD + WIND LOAD
f. DEAD LOAD + LIVE LOAD + SNOW LOAD + SEISMIC LOAD

G. SOIL BEARING VALUE:

1. DESIGN SOIL BEARING PRESSURE FOR SPREAD FOOTINGS IS ASSUMED TO BE 150 kPa.

H. FOOTINGS:

1. BOTTOMS OF ALL FOOTINGS SHALL EXTEND 300mm MINIMUM INTO UNDISTURBED SOIL AND, WHERE SUBJECT TO FROST ACTION, AT LEAST 1000mm BELOW FINISHED GRADE.

I. CAST-IN-PLACE CONCRETE CONSTRUCTION:

1. CONCRETE WORK SHALL CONFORM TO ALL REQUIREMENTS OF THE UNIFORM BUILDING CODE, "ENGINEERING REGULATIONS – QUALITY AND DESIGN OF THE MATERIALS OF CONSTRUCTION", CHAPTER 26.
2. ALL CONCRETE WORK SHALL CONFORM TO ALL CODE SPECIFIED SPECIAL PROVISIONS FOR SEISMIC ZONE 4.
3. CONCRETE CONSTRUCTION SHALL CONFORM TO THE FOLLOWING CRITERIA:

Structure Type	Minimum Ultimate Compressive Strength at 28 Days F'c (kg/cm2)	Maximum Water Cement Ratio	Entrained Air Range (%)
Footings	210	0.55	6 –8
Walls	210	0.55	6 –8

4. ALL CONCRETE FOR THE STRUCTURAL BUILDING ROOF SYSTEM SHALL BE NORMAL WEIGHT CONCRETE. ALL CONCRETE FOR THE SLOPED TOPPING SLAB SHALL BE LIGHTWEIGHT CONCRETE WITH A UNIT WEIGHT OF 115–118 POUNDS PER CUBIC FOOT.
5. ADD HIGH-RANGE WATER REDUCING ADMIXTURE (SUPER PLASTICIZER) TO CONCRETE MIX FOR PUMPED CONCRETE AND WHERE REQUIRED FOR WORKABILITY. LIMIT SLUMP IN CONCRETE TO 8" AFTER ADDITION OF HIGH RANGE WATER REDUCER TO VERIFIED 2"–3" SLUMP CONCRETE. SEE CONTRACT SPECIFICATIONS. ADMIXTURE DOSAGE, ADDITION TIMES, COMPATIBILITY WITH OTHER ADMIXTURES, AND COMPATIBILITY WITH OTHER MIX CONSTITUENTS SHALL BE THE RESPONSIBILITY OF THE MANUFACTURER.
6. CONCRETE TEST CYLIDERS SHALL BE TAKEN IN ACCORDANCE WITH THE REQUIREMENTS OF ACI 318–89, CHAPTER 5 AND THE CONTRACT SPECIFICATIONS.
7. FOOTING DOWELS FOR WALLS AND COLUMNS SHALL PROJECT A MINIMUM OF 30 BAR DIAMETERS ABOVE FOOTING.

J. CONCRETE REINFORCEMENT:

1. STEEL REINFORCEMENT FOR CONCRETE SHALL BE HIGH STRENGTH NEW BILLET DEFORMED BARS CONFORMING TO ASTM A615M, GRADE 400 (S420).
2. CONCRETE PROTECTION FOR STEEL REINFORCEMENT OF CAST-IN-PLACE CONCRETE SHALL BE AS FOLLOWS:

	Not Exposed to Earth or Weather in Service	f 16 or smaller	f 20 or larger	Earth Formed
Walls	3/4"	1 1/2"	2"	–
Footings	–	3"	3"	3"

V. STRUCTURAL STEEL:

1. STRUCTURAL STEEL SHALL CONFORM TO THE AISC "SPECIFICATION FOR STRUCTURAL STEEL BUILDINGS – ALLOWABLE STRESS DESIGN AND PLASTIC DESIGN" (6/1/89).
2. STRUCTURAL STEEL SHALL CONFORM TO St 37,2 WITH A MINIMUM YIELD STRENGTH OF Fy = 2400 kg/cm2.
3. STRUCTURAL STEEL PIPES SHALL HAVE A MINIMUM YIELD STRENGTH OF Fy = 2400 kg/cm2.
4. SHOP CONNECTIONS SHALL BE WELDED
5. FIELD CONNECTIONS SHALL BE MADE WITH ASTM A325N BOLTS UNLESS OTHERWISE NOTED.
6. UNLESS OTHERWISE NOTED, HIGH STRENGTH BOLTS SHALL BE TIGHTENED TO A SNUG TIGHT CONDITION AS DEFINED BY THE AISC "SPECIFICATION FOR STRUCTURAL JOINTS USING ASTM A325 OR A490 BOLTS" (LATEST EDITION).
7. STRUCTURAL STEEL BELOW GRADE SHALL HAVE A MINIMUM OF 3" CONCRETE COVER.
8. ALL WELDING SHALL CONFORM TO THE AMERICAN WELDING SOCIETY STRUCTURAL WELDING CODE – STEEL, AWS D1.1 (LATEST EDITION). WELDS SHALL BE INSTALLED BY WELDERS QUALIFIED IN ACCORDANCE WITH AWS PROCEDURES FOR WELDER QUALIFICATION.
9. WELDING INSPECTION SHALL BE MADE IN ACCORDANCE WITH THE INSPECTION CHAPTER OF AWS D1.1 (LATEST EDITION).
10. INSPECTION SHALL BE PERFORMED BY A RECOGNIZED INDEPENDENT TESTING LABORATORY.
11. UNLESS OTHERWISE NOTED, ONE SHOP COAT OF FABRICATORS STANDARD PRIMER PAINT, TWO MILS DRY FILM THICKNESS, SHALL BE APPLIED TO ALL STRUCTURAL MEMBERS EXCEPT THOSE EMBEDDED IN CONCRETE .

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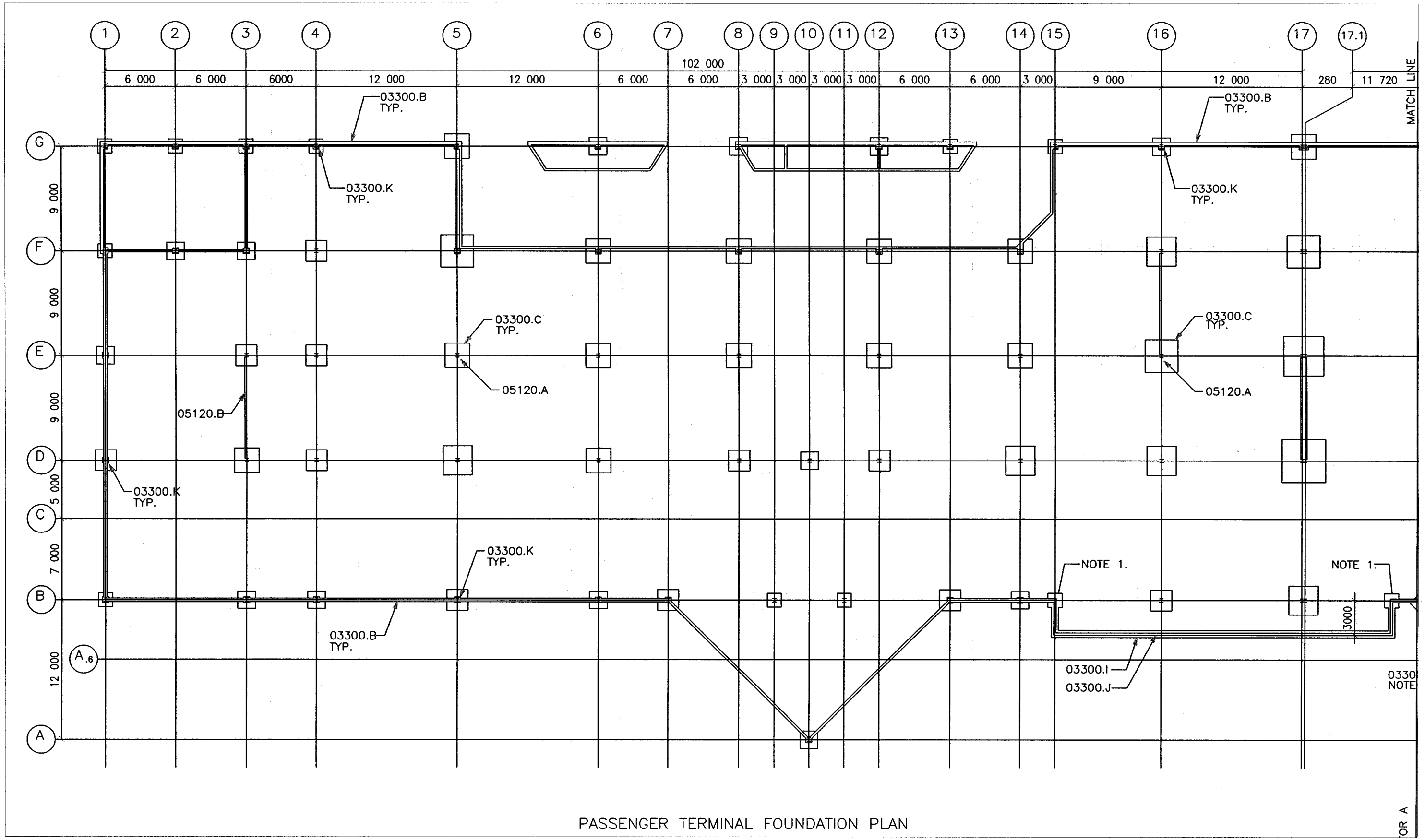
NACALA INTERNATIONAL AIRPORT
NAMPULA PROVINCE
MOZAMBIQUE

STRUCTURAL NOTES

DRAWING No. SA 01



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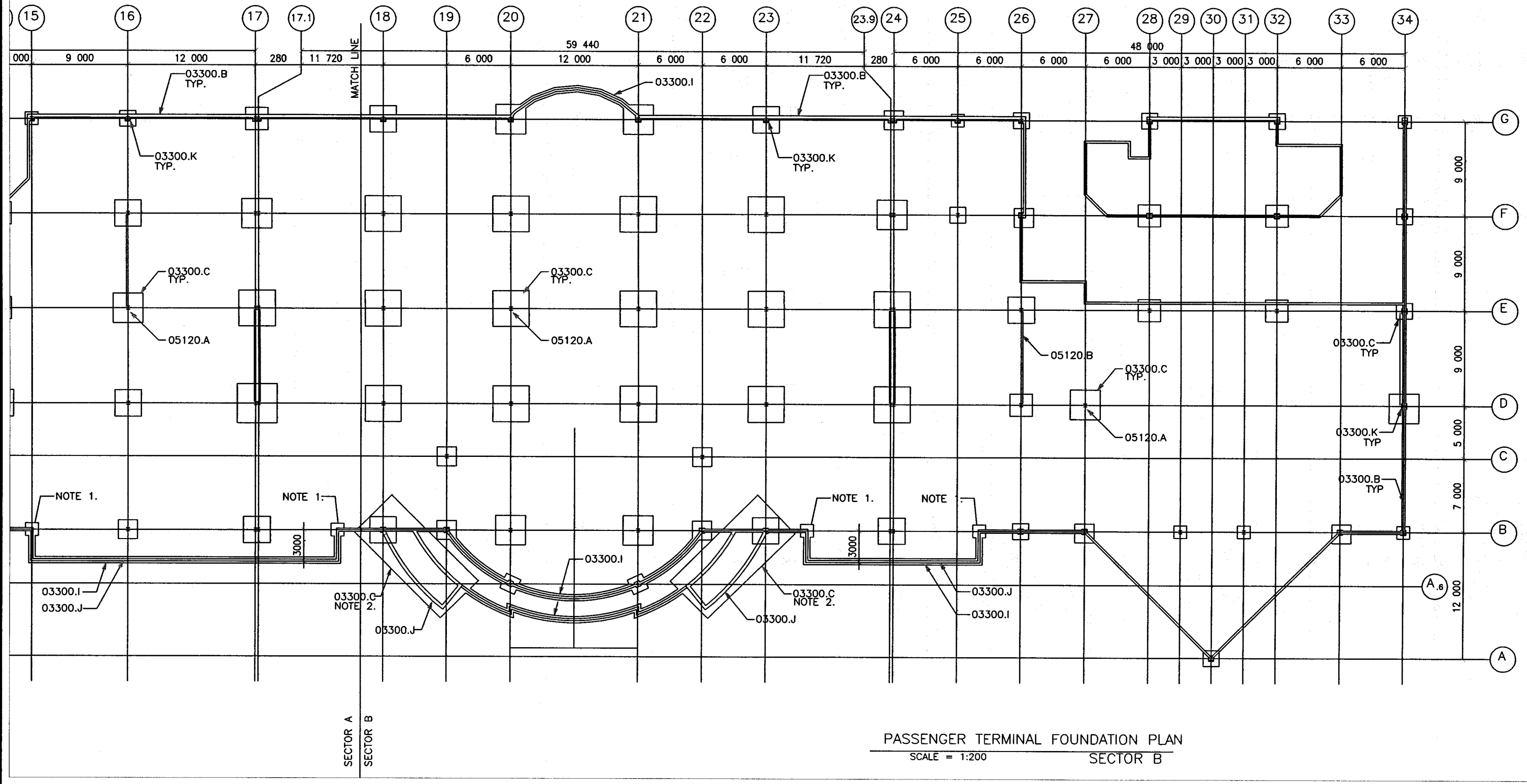
NACALA INTERNATIONAL AIRPORT
NAMPULA PROVINCE
MOZAMBIQUE

TERMINAL FOUNDATION PLAN
ARRIVAL AREA
DRAWING No. SA 02



PASSENGER TERMINAL FOUNDATION PLAN

SCALE = 1:200 SECTOR B

REV. No.	DATE	DESCRIPTION	BY	CHECK	APRO.

AIRPORTS DE MOZAMBIQUE

MAPUTO, MOZAMBIQUE

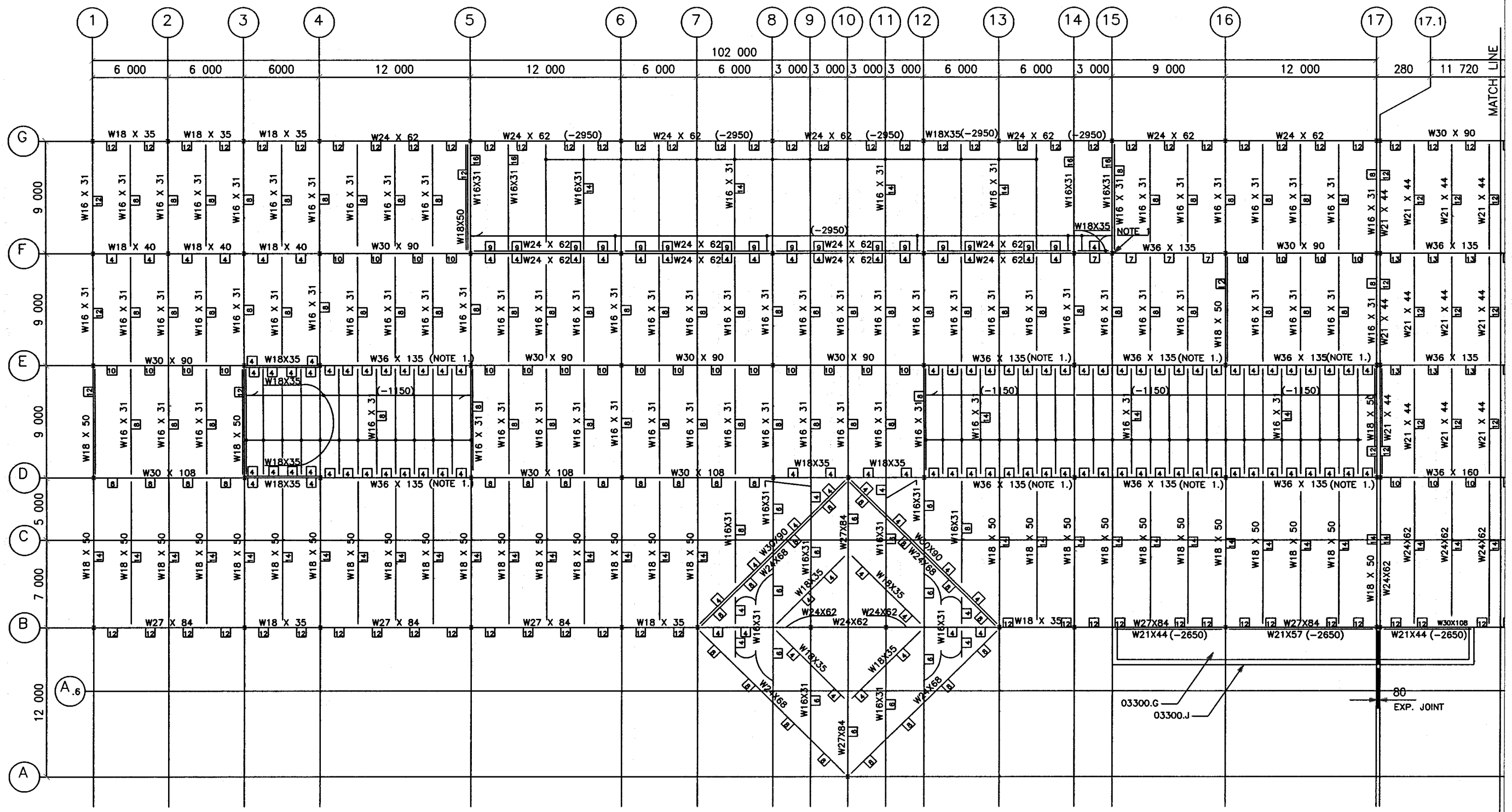
CONSULTANTS: AAROTEC INFRASTRUCTURE GROUP INC.
ALBERT C. YOUNG P.E.
WEB SITE: WWW.AAROTEC.COM
E-MAIL: AAROTEC@AAROTEC.COM

DESIGNED	DRAWN	CHECKED	APPROVED	APPROVED
C.M.	ILA	ACY		
	DATE 10/07	DATE 10/07	DATE 12/10	DATE
SCALE	ISSUE DATE	PROJECT No.	SERIES No.	
INDICATED	06/07	8028		

NACALA INTERNATIONAL AIRPORT
NAMPULA PROVINCE
MOZAMBIQUE

TERMINAL FOUNDATION PLAN
DEPARTURE AREA

DRAWING No. SA 03



ELEV. T/STEEL = 5850 FROM FINISH FLOOR REFERENCE ELEVATION OF 0.0
UNLESS NOTED OTHERWISE ON PLAN AS +/-XXX FROM ELEVATION 5850

[x] INDICATES NUMBER OF Ø20 X 75mm HEADED CONCRETE STUDS

VERTICLE CROSS BRACING, 05200.B

PASSENGER TERMINAL FRAMING PLAN

SCALE = 1:200 SECTOR A

REV. No.	DATE	DESCRIPTION	BY	CHECK	APRO.

AIRPORTS DE MOZAMBIQUE
MAPUTO, MOZAMBIQUE

CONSULTANTS: AAROTEC INFRASTRUCTURE GROUP INC.
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C.M.	ILA	ACY		
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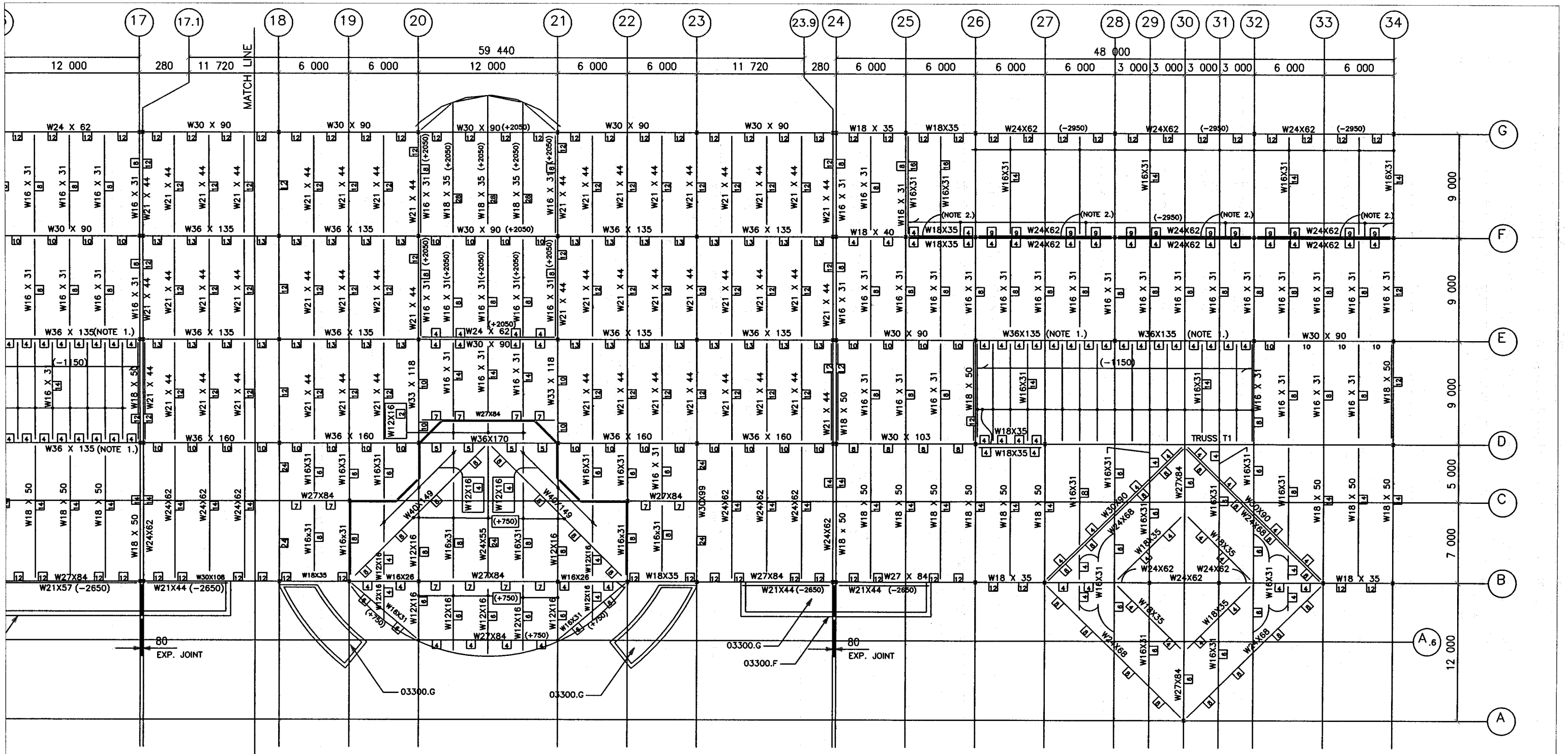
NACALA INTERNATIONAL AIRPORT
NAMPULA PROVINCE
MOZAMBIQUE

TERMINAL FRAMING PLAN
ARRIVAL AREA

DRAWING No. SA 04



ELEV. T/STEEL = 5850 FROM FINISH FLOOR REFERENCE ELEVATION OF 0.0
UNLESS NOTED OTHERWISE ON PLAN AS +/-XXX FROM ELEVATION 5850

INDICATES NUMBER OF |20 X 75mm HEADED CONCRETE STUDS

VERTICLE CROSS BRACING, 05200.B

PASSENGER TERMINAL FRAMING PLAN

SCALE = 1:200 SECTOR B

REV. No.	DATE	DESCRIPTION	BY	CHECK	APRO.

AIRPORTS DE MOZAMBIQUE
MAPUTO, MOZAMBIQUE

CONSULTANTS: AAROTEC INFRASTRUCTURE GROUP INC.
ALBERT C. YOUNG P.E.
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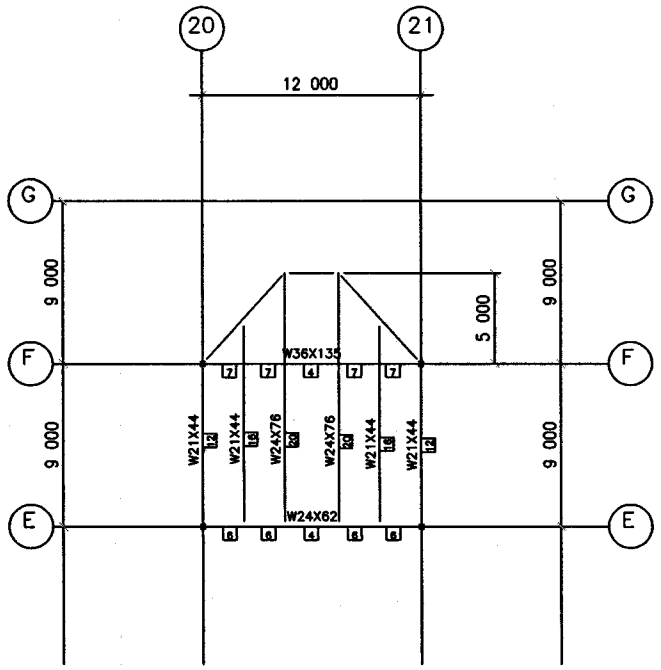
C.M.	ILA	ACY		
	DATE 10/07	DATE 10/07	DATE 12/10	DATE
SCALE	ISSUE DATE	PROJECT No.	SERIES No.	
INDICATED	06/07	8029		

NACALA INTERNATIONAL AIRPORT
NAMPULA PROVINCE
MOZAMBIQUE

TERMINAL FRAMING PLAN
DEPARTURE AREA

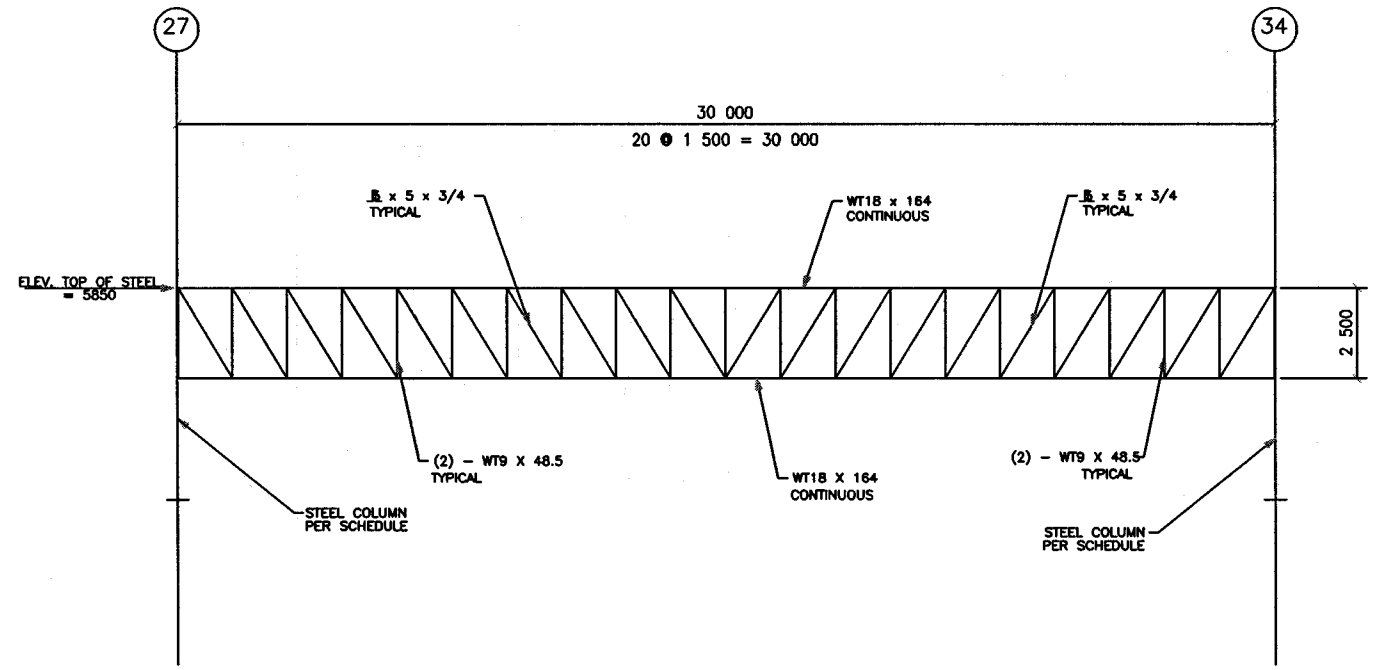
DRAWING No. SA 05



ELEV. T/STEEL = 4700 FROM FINISH FLOOR REFERENCE ELEVATION OF 0.0
UNLESS NOTED OTHERWISE ON PLAN AS +/−XXX FROM ELEVATION 4700

[x] INDICATES NUMBER OF ø20 X 75mm HEADED CONCRETE STUDS

PASSENGER TERMINAL SECOND FLOOR FRAMING PLAN
SCALE = 1:200



PASSENGER TERMINAL – TRUSS T1 ELEVATION
SCALE = 1:100

REV. No.	DATE	DESCRIPTION	BY	CHECK	APRO.

AIRPORTS DE MOZAMBIQUE
MAPUTO, MOZAMBIQUE

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C.M.	ILA	ACY		
	DATE 10/07	DATE 10/07	DATE 12/10	DATE
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INDICATED	06/07	8028		

NACALA INTERNATIONAL AIRPORT
NAMPULA PROVINCE
MOZAMBIQUE

TERMINAL FRAMING PLAN
SECOND FLOOR
DRAWING No. SA 06

COLUMN SCHEDULE

MARK	A10 A30	B1 G4 G15	B3 B4 B6 D10 F2 F3 G16	B5 C19 C22 D1	B14 B26 E1 E34 F25 F34	B7 B13 B16 B27 B33 E4 F26	D3 E5 E6 E8 E12 E28 E32	B18 B23 D14 D16 E26	D4 E3	B20 B21	B34	D5	D6 D26 E14 F6 F8 F12 F14 F28 F32	D8 D12 F4	D18 D20 D21 D23	D34 E16 F5	E18 E23 F18 F23	E20 E21 F20 F21	F1 G2 G3 G25	G18 G23	B9 B11 B29 B31	G1	G6 G8 G12 G26 G28 G32	G13 G34	G20 G21	D27	F16	G5	B19 B22
HIGH ROOF (7900)																													
LOBBY ROOF (6600)																													
MAIN ROOF (5850)																													
INTERMEDIATE ROOF (4400)																													
LOW ROOF (2900)																													
FINISHED FLOOR (00.00)	W12X45	W12X45	W12X45	W12X45	W12X45	W12X45	W12X53	W12X53	W12X53	W12X65	W12X45	W12X53	W12X53	W12X45	W12X87	W12X65	W12X79	W12X79	W12X45	W12X53	W12X45	W12X45	W10X33	W10X33	W12X65	W12X65	W12X53	W12X53	W12X53
REACTION	60k	40k	60k	80k	70k	100k	130k	160k	110k	230k	20k	150k	140k	90k	350k	200k	340k	340k	30k	170k	15k	15k	60k	30k	230k	240k	180k	120k	110k
FOOTING	F2	F1	F2	F3	F2	F3	F4	F5	F3	F6	F1	F5	F4	F3	F8	F6	F8	F8	F1	F5	F1	F1	F2	F1	F6	F6	F5	F4	F3

MARK	G23.9	G24	G17.1	G17	B17 B24	B17.1 B23.9	F17	F17.1	D24	D23.9	D17	D17.1	F24	F23.9	E17	E17.1	E24	E23.9	A.6 20 A.6 21
HIGH ROOF (7900)																			
LOBBY ROOF (6600)																			
MAIN ROOF (5850)																			
INTERMEDIATE ROOF (4400)																			200 STD. STL. PIPE
LOW ROOF (2900)																			
FINISHED FLOOR (00.00)	W12X45	W12X45	W12X45	W12X45	W12X45	W12X53	W12X45	W12X53	W12X45	W12X65	W12X45	W12X79	W12X45	W12X53	W12X45	W12X53	W12X45	W12X79	
REACTION	105k		120k		180k		230k		320k		400k		200k		360k		350k		70k
FOOTING	F3		F4		F5		F6		F8		F9		F6		F8		F8		F2

FOOTING SCHEDULE

FOOTING	SIZE (W X L X T)	REINFORCING
F1	1 200 X 1 200 X 300	|16 @ 240 O.C.
F2	1 500 X 1 500 X 300	|16 @ 240 O.C.
F3	1 800 X 1 800 X 350	|16 @ 280 O.C.
F4	2 100 X 2 100 X 430	|20 @ 380 O.C.
F5	2 500 X 2 500 X 480	|22 @ 450 O.C.
F6	2 800 X 2 800 X 540	|20 @ 280 O.C.
F7	3 100 X 3 100 X 600	|22 @ 360 O.C.
F8	3 400 X 3 400 X 660	|22 @ 300 O.C.
F9	3 700 X 3 700 X 720	|25 @ 380 O.C.

NOTE:
REACTIONS ARE THEORITICAL;
MUST BE VERIFIED BY FIELD TEST

REV. No.	DATE	DESCRIPTION	BY	CHECK	APRO.

AIRPORTS DE MOZAMBIQUE
MAPUTO, MOZAMBIQUE

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C.M.	ILA	ACY		
	DATE 10/07	DATE 10/07	DATE 12/10	DATE
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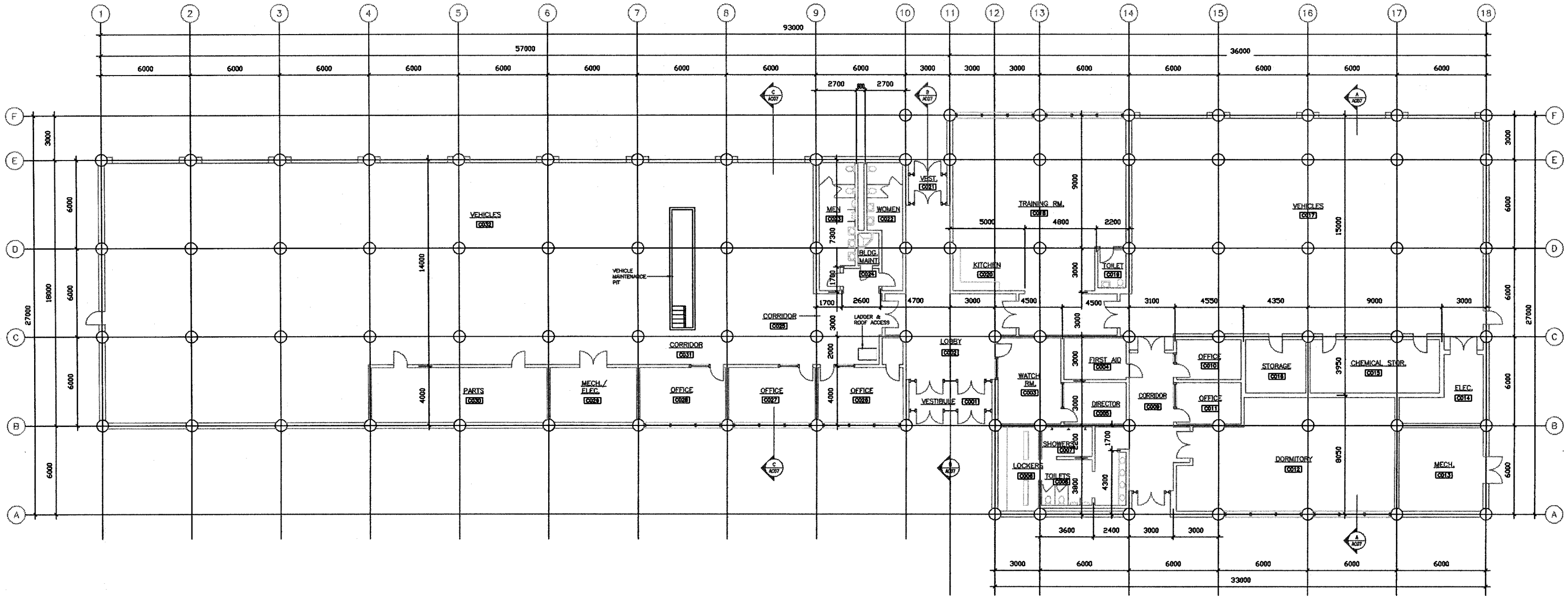
INDICATED	06/07	8028		

NACALA INTERNATIONAL AIRPORT
NAMPULA PROVINCE
MOZAMBIQUE

TERMINAL FRAMING DETAILS
COLUMN SCHEDULE
DRAWING No. SA 07



ARFF/AIRFIELD MAINTENANCE BUILDING FLOOR PLAN

REV. No.	DATE	DESCRIPTION	BY	CHECK	APRO.

AIRPORTS DE MOZAMBIQUE
MAPUTO, MOZAMBIQUE

CONSULTANTS: AAROTEC INFRASTRUCTURE GROUP INC.
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DESIGNED	DRAWN	CHECKED	APPROVED	APPROVED
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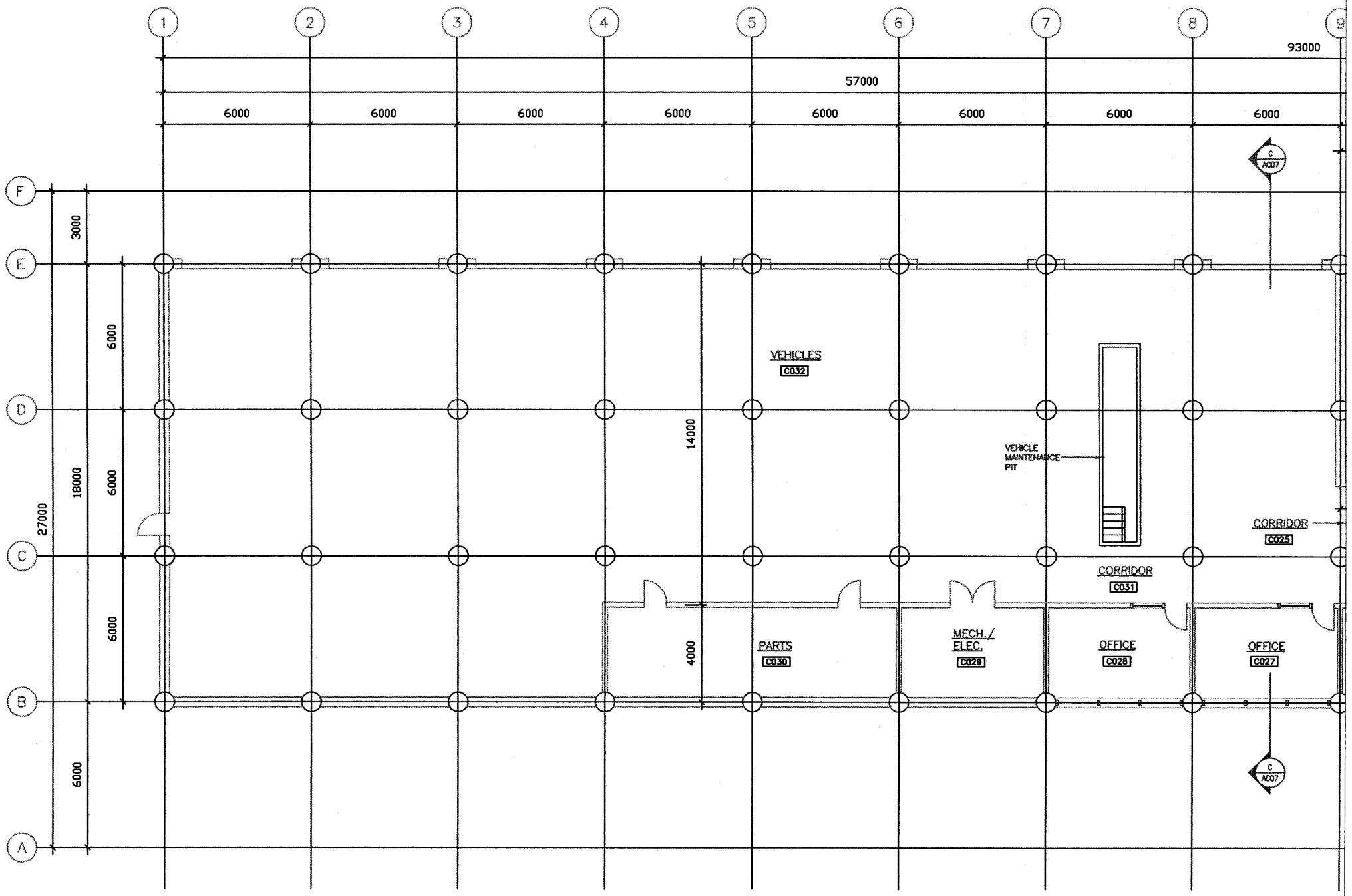
	DATE 10/07	DATE 10/07	DATE 12/10	DATE
SCALE	ISSUE DATE	PROJECT No.	SERIES No.	
INDICATED	06/07	8028		

NACALA INTERNATIONAL AIRPORT
NAMPULA DISTRICT
MOZAMBIQUE

ARFF & AFM FLOOR PLAN

DRAWING No. ARFF01



REV. No.	DATE	DESCRIPTION	BY	CHECK	APRO.

AIRPORTS DE MOZAMBIQUE
MAPUTO, MOZAMBIQUE

CONSULTANTS: AAROTEC INFRASTRUCTURE GROUP INC.
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C.M.	ILA	ACY		
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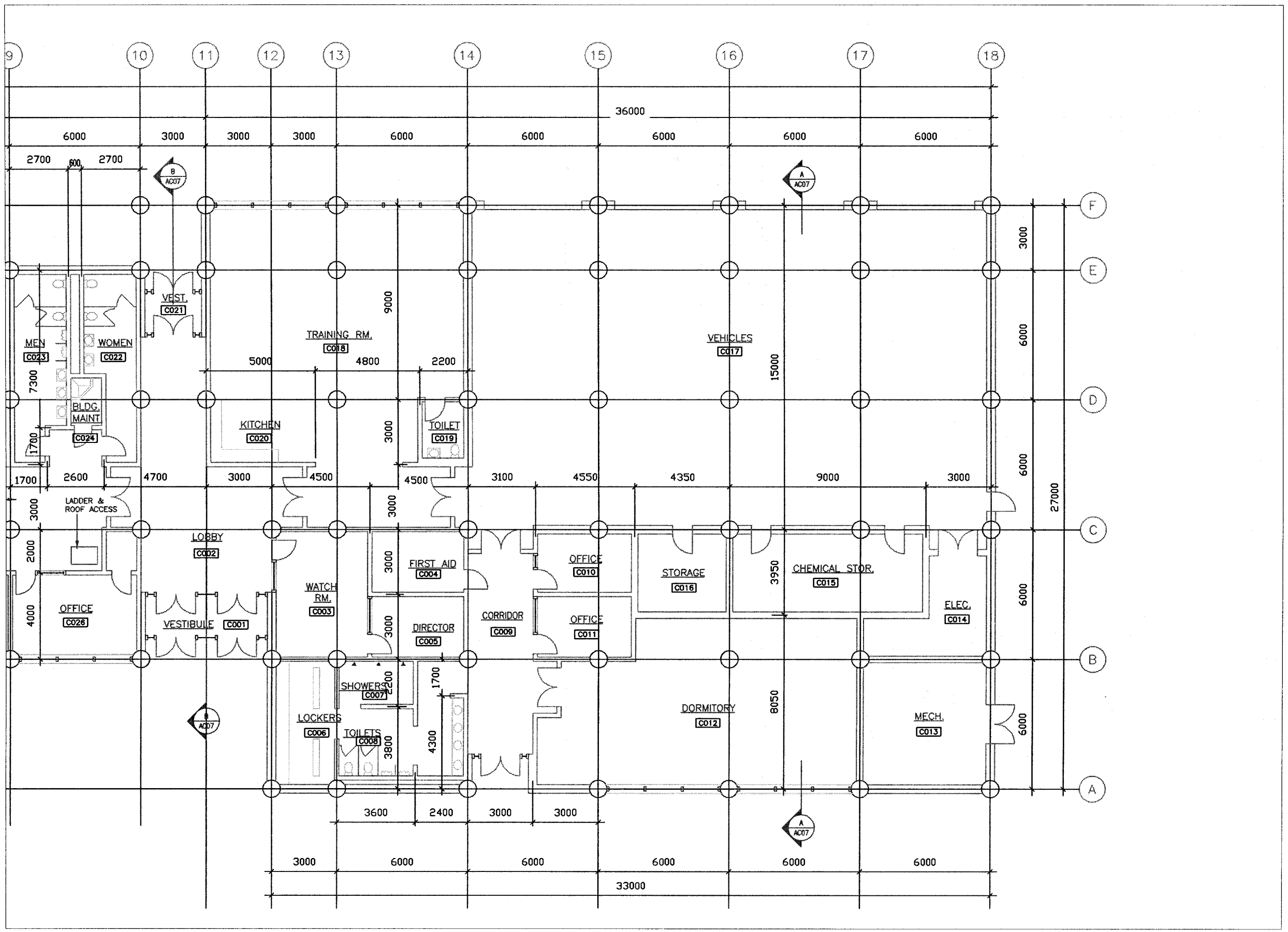
INDICATED	06/07	8028		

NACALA INTERNATIONAL AIRPORT
NAMPULA DISTRICT
MOZAMBIQUE

ARFF & AFM FLOOR PLAN
SECTOR A

DRAWING No. ARFF02



REV. No.	DATE	DESCRIPTION	BY	CHECK	APRO.

AIRPORTS DE MOZAMBIQUE
MAPUTO, MOZAMBIQUE

CONSULTANTS: AAROTEC INFRASTRUCTURE GROUP INC.
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C.M.	ILA	ACY		
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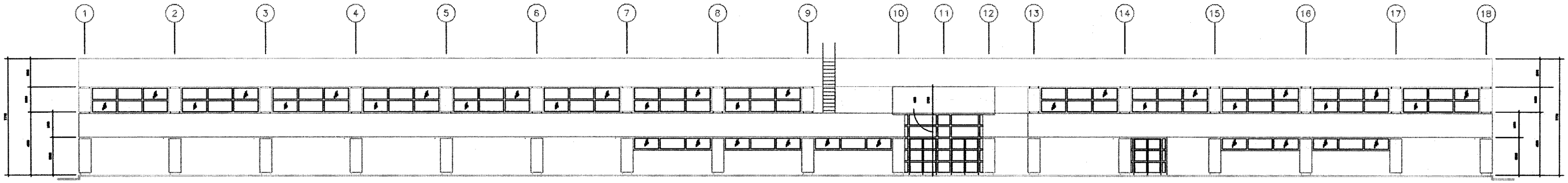
SCALE	ISSUE DATE	PROJECT No.	SERIES No.	
INDICATED	06/07	8028		

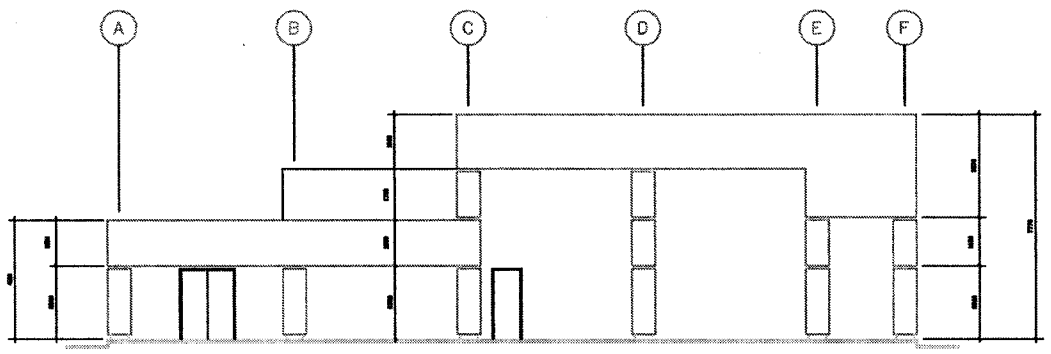
NACALA INTERNATIONAL AIRPORT
NAMPULA DISTRICT
MOZAMBIQUE

ARFF & AFM FLOOR PLAN
SECTOR B

DRAWING No. ARFF03



BACK ELEVATION



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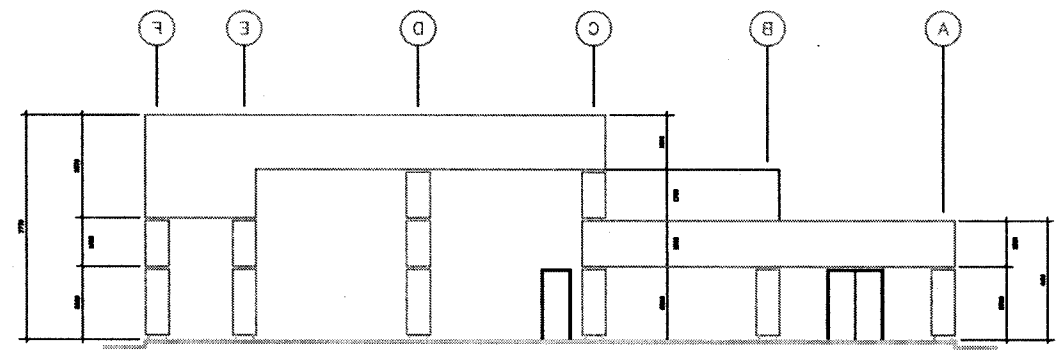
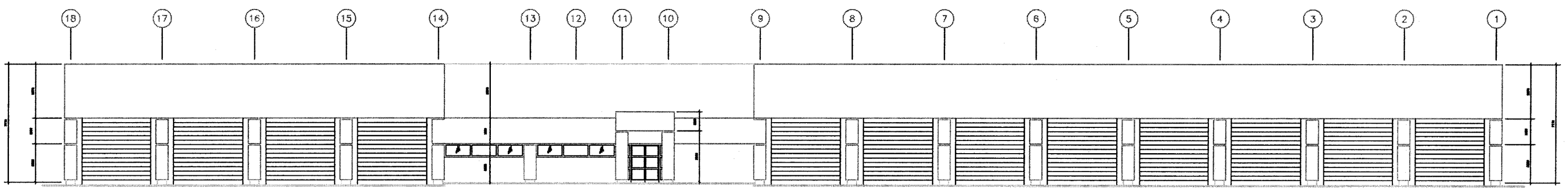


RIGHT END



FRONT ELEVATION

REV. No.	DATE	DESCRIPTION	BY	CHECK	APRO.

AIRPORTS DE MOZAMBIQUE
MAPUTO, MOZAMBIQUE

CONSULTANTS: AAROTEC INFRASTRUCTURE GROUP INC.
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C.M.	ILA	ACY		
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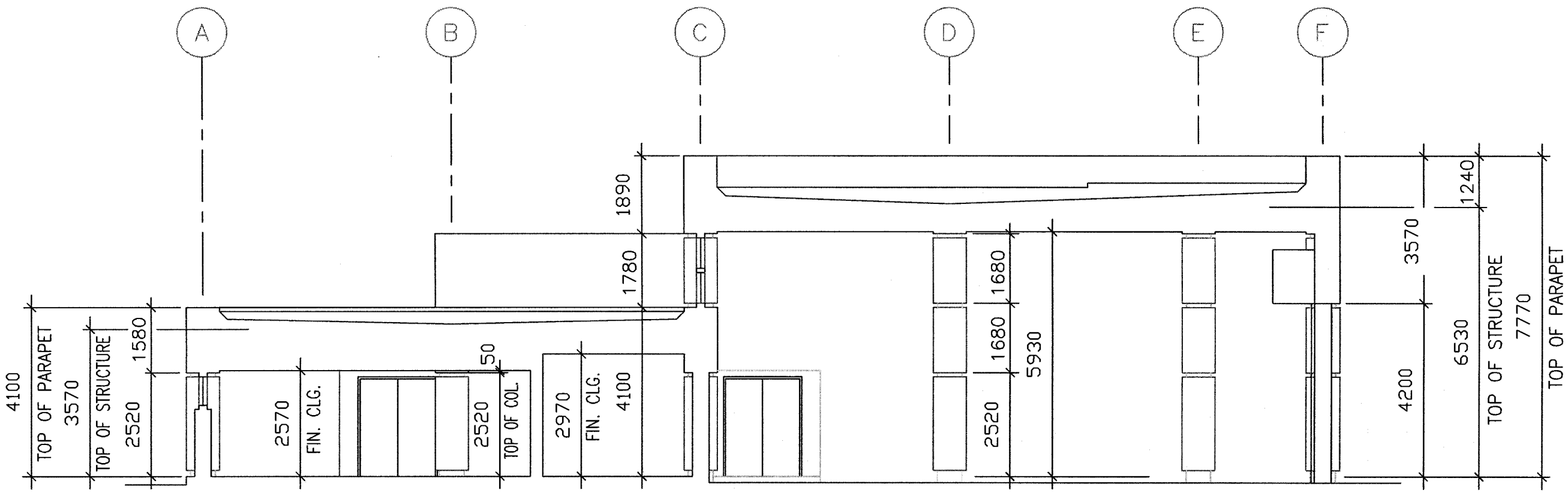
SCALE	ISSUE DATE	PROJECT No.	SERIES No.	
INDICATED	06/07	8028		

NACALA INTERNATIONAL AIRPORT
NAMPULA DISTRICT
MOZAMBIQUE

ARFF & AFM ELEVATIONS

DRAWING No. ARFF04



SECTION A

NEW ARFF & AFM BUILDING

REV. No.	DATE	DESCRIPTION	BY	CHECK	APRO.

AIRPORTS DE MOZAMBIQUE
MAPUTO, MOZAMBIQUE

CONSULTANTS: AAROTEC INFRASTRUCTURE GROUP INC.
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C.M.	ILA	ACY		
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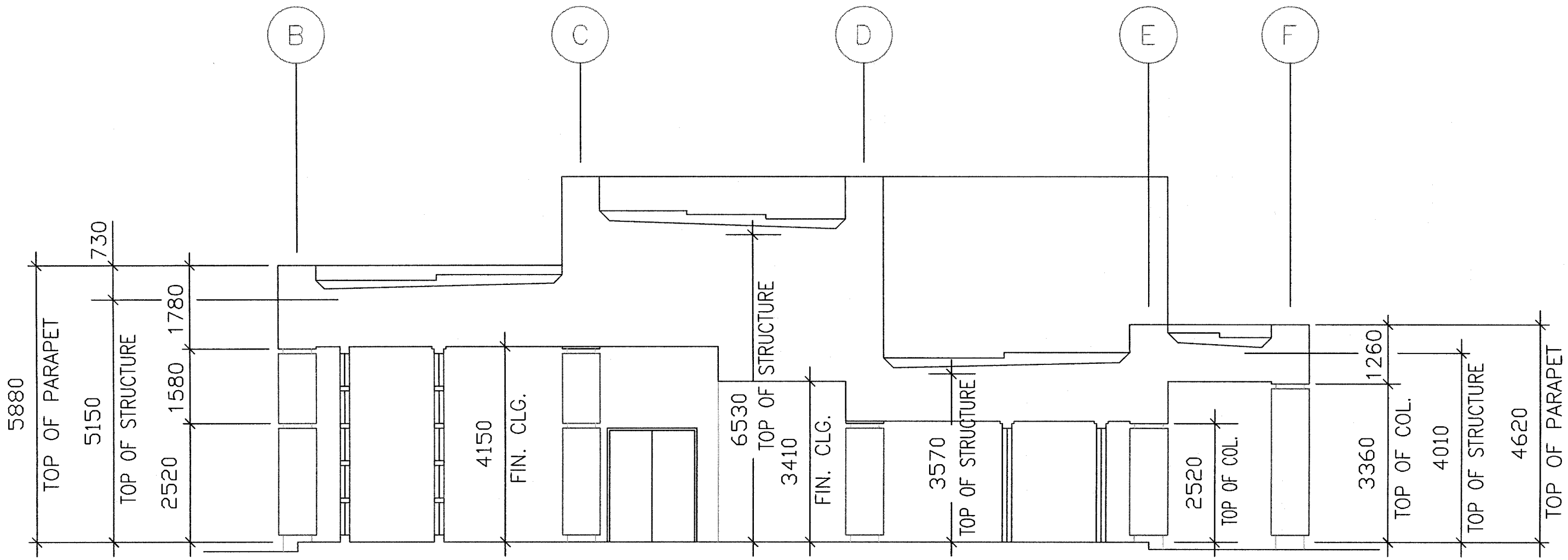
INDICATED	06/07	8028		

NACALA INTERNATIONAL AIRPORT
NAMPULA DISTRICT
MOZAMBIQUE

ARFF & AFM SECTION 'A'

DRAWING No. ARFF05



SECTION B

ARFF & AFM BUILDING

REV. No.	DATE	DESCRIPTION	BY	CHECK	APRO.

AIRPORTS DE MOZAMBIQUE
MAPUTO, MOZAMBIQUE

CONSULTANTS: AAROTEC INFRASTRUCTURE GROUP INC.
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C.M.	ILA	ACY		
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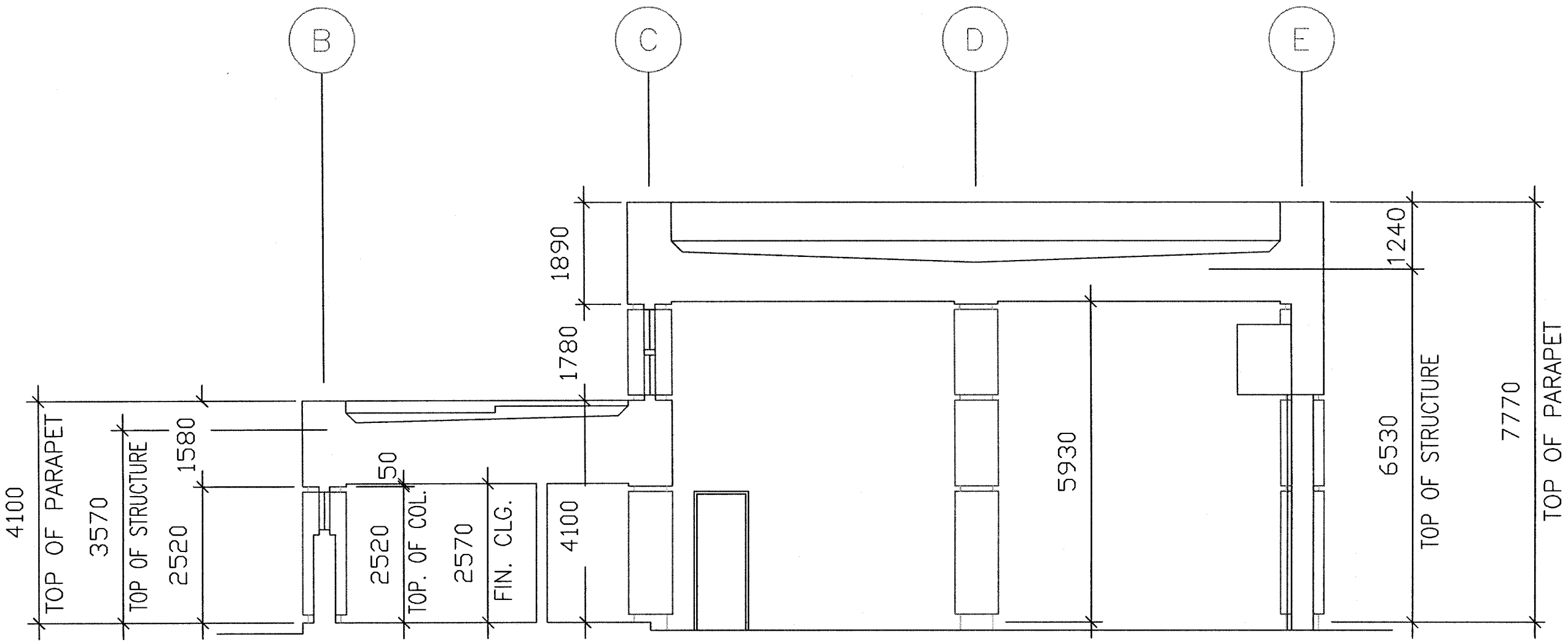
INDICATED	06/07	8028		

NACALA INTERNATIONAL AIRPORT
NAMPULA DISTRICT
MOZAMBIQUE

ARFF & AFM SECTION 'B'

DRAWING No. ARFF06



SECTION C

ARFF & AFM BUILDING

REV. No.	DATE	DESCRIPTION	BY	CHECK	APRO.

AIRPORTS DE MOZAMBIQUE
MAPUTO, MOZAMBIQUE

CONSULTANTS: AAROTEC INFRASTRUCTURE GROUP INC.
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C.M.	ILA	ACY		
	DATE 10/07	DATE 10/07	DATE 12/10	DATE
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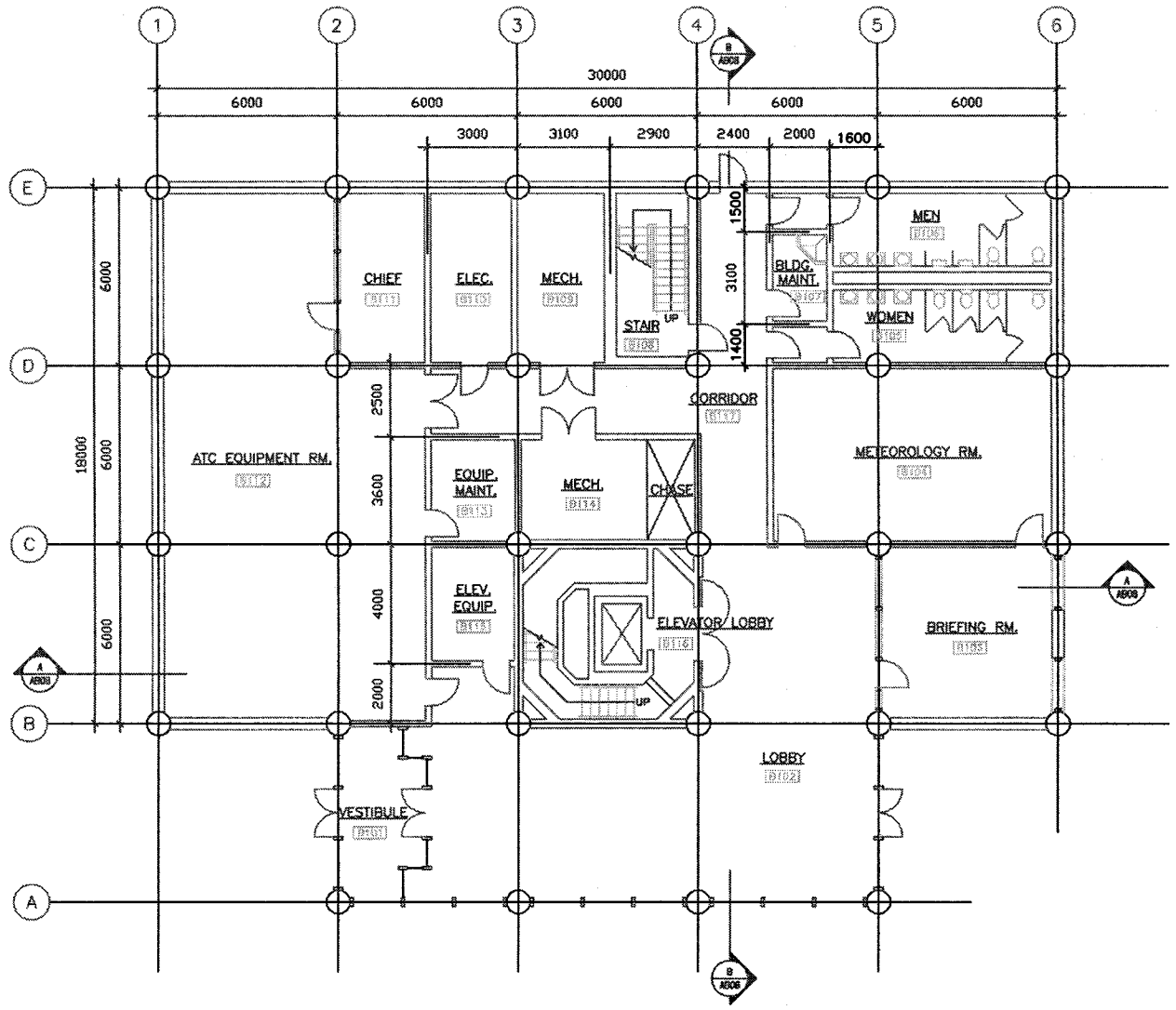
INDICATED	06/07	8028		

NACALA INTERNATIONAL AIRPORT
NAMPULA DISTRICT
MOZAMBIQUE

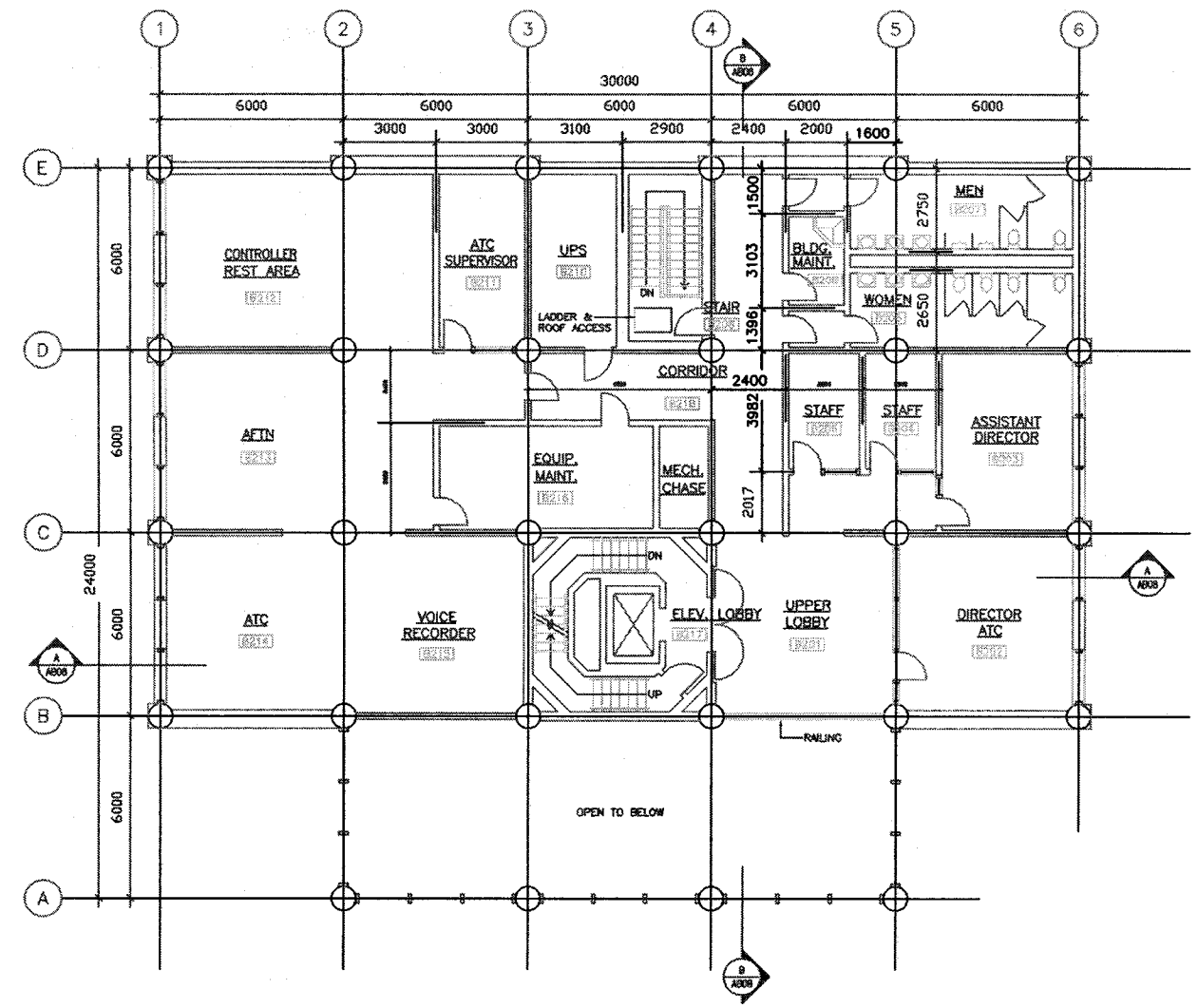
ARFF & AFM SECTION 'C'

DRAWING No. ARFF07



ATC BUILDING FLOOR PLAN

LEVEL 1



ATC BUILDING FLOOR PLAN

LEVEL 2

REV. No.	DATE	DESCRIPTION	BY	CHECK	APRO.

AIRPORTS DE MOZAMBIQUE
MAPUTO, MOZAMBIQUE

CONSULTANTS: AAROTEC INFRASTRUCTURE GROUP INC.
ALBERT C. YOUNG P.E.
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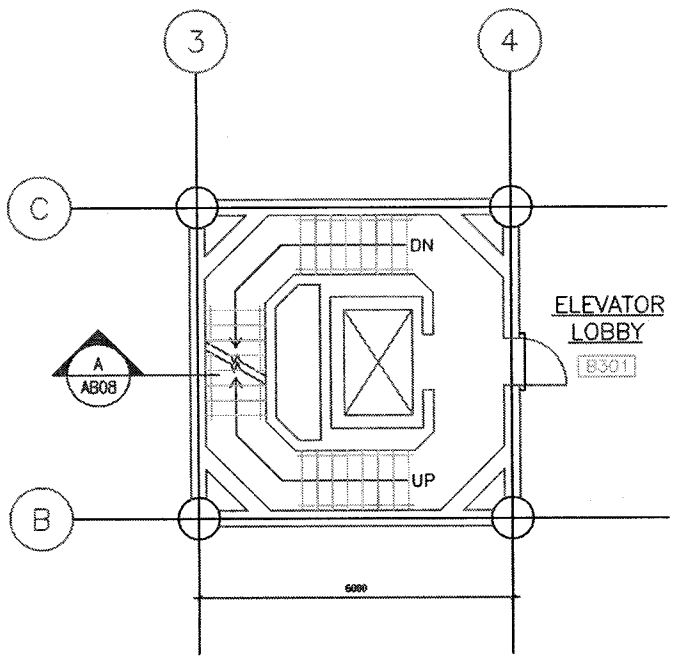
E-MAIL: AAROTEC@AAROTEC.COM

DESIGNED	DRAWN	CHECKED	APPROVED	APPROVED
C.M.	II.A	ACY		
	DATE 10/07	DATE 10/07	DATE	DATE
SCALE	ISSUE DATE	PROJECT No.	SERIES No.	
INDICATED	06/07			

NACALA INTERNATIONAL AIRPORT
NAMPULA PROVINCE
MOZAMBIQUE

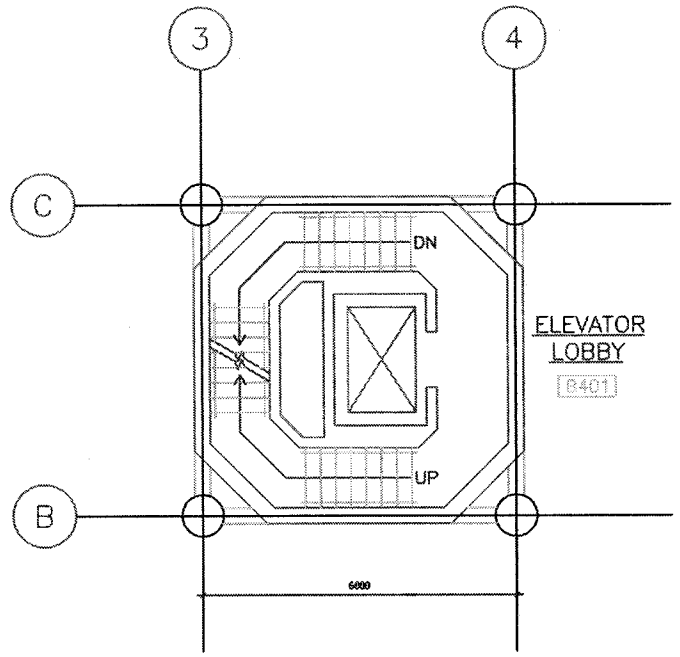
ATC BUILDING
FLOOR PLANS 1 & 2

DRAWING No. ATC01



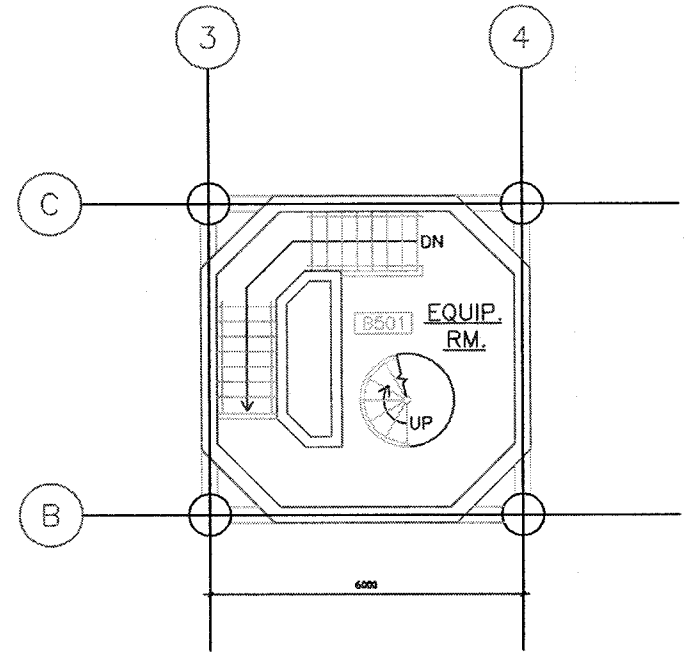
ATC BUILDING FLOOR PLAN

LEVEL 3 (ROOF)



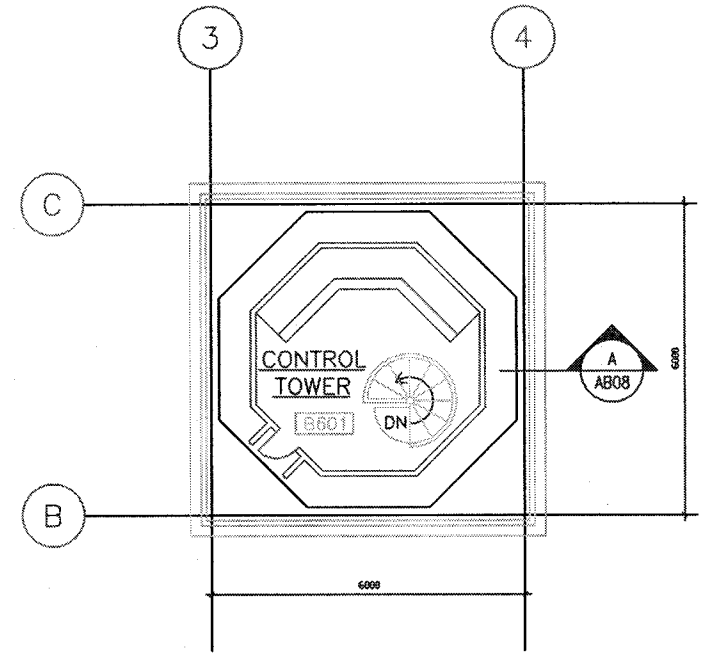
ATC BUILDING FLOOR PLAN

LEVEL 4



ATC BUILDING FLOOR PLAN

LEVEL 5



ATC BUILDING FLOOR PLAN

LEVEL 6 (CAB)

REV. No.	DATE	DESCRIPTION	BY	CHECK	APRO.

AIRPORTS DE MOZAMBIQUE
MAPUTO, MOZAMBIQUE

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ALBERT C. YOUNG P.E.
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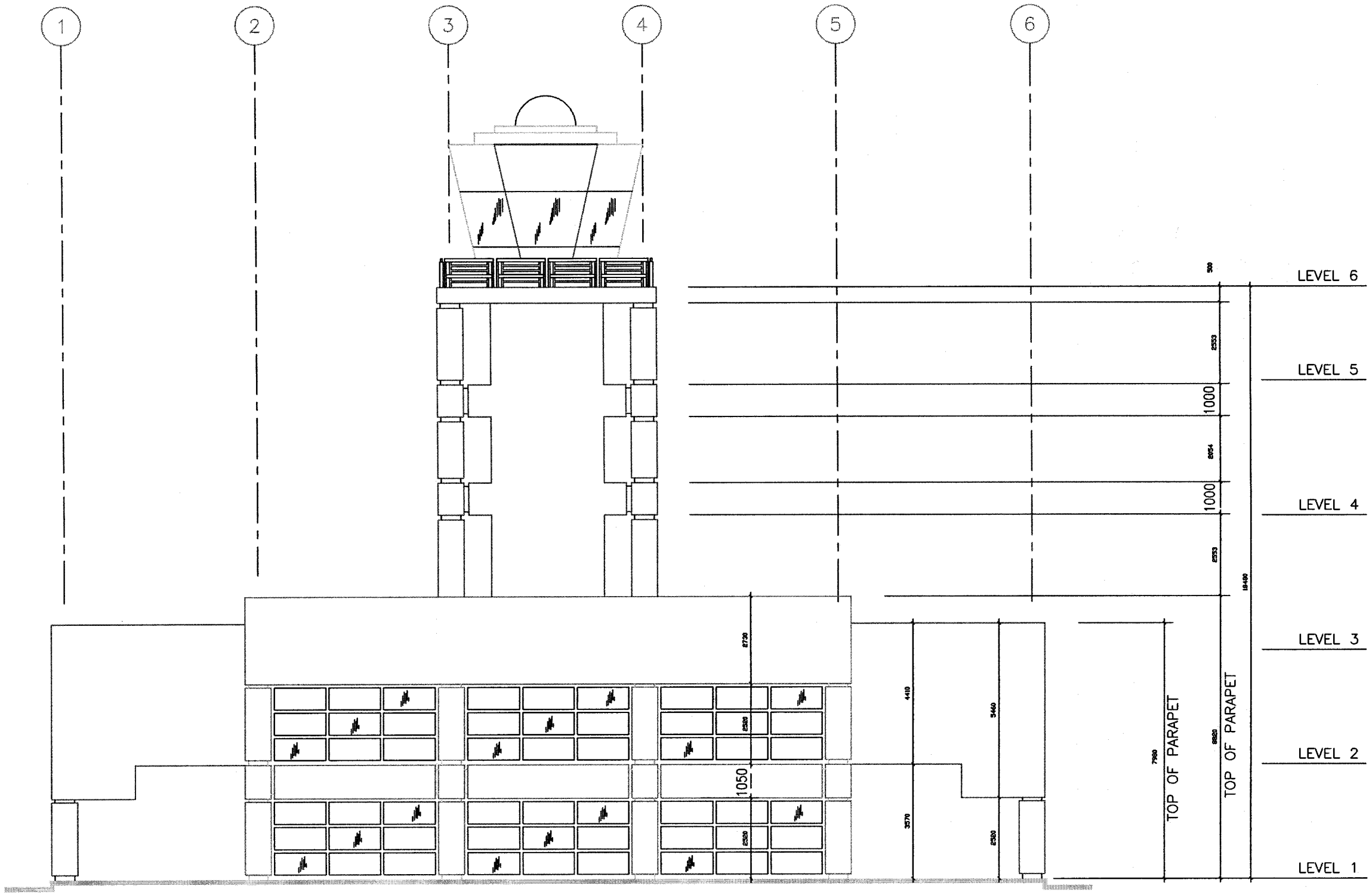
E-MAIL: AAROTEC@AAROTEC.COM

DESIGNED	DRAWN	CHECKED	APPROVED	APPROVED
C.M.	ILA	ACY		
	DATE 10/07	DATE 10/07	DATE	DATE
SCALE	ISSUE DATE	PROJECT No.	SERIES No.	
INDICATED	06/07			

NACALA INTERNATIONAL AIRPORT
NAMPULA PROVINCE
MOZAMBIQUE

ATC BUILDING
FLOOR PLAN 3-4-5 & 6

DRAWING No. ATC02



AIR TRAFFIC CONTROL BUILDING

FRONT ELEVATION

REV. No.	DATE	DESCRIPTION	BY	CHECK	APPRO.

AIRPORTS DE MOZAMBIQUE

MAPUTO, MOZAMBIQUE

CONSULTANTS: AAROTEC INFRASTRUCTURE GROUP INC.
ALBERT C. YOUNG P.E.

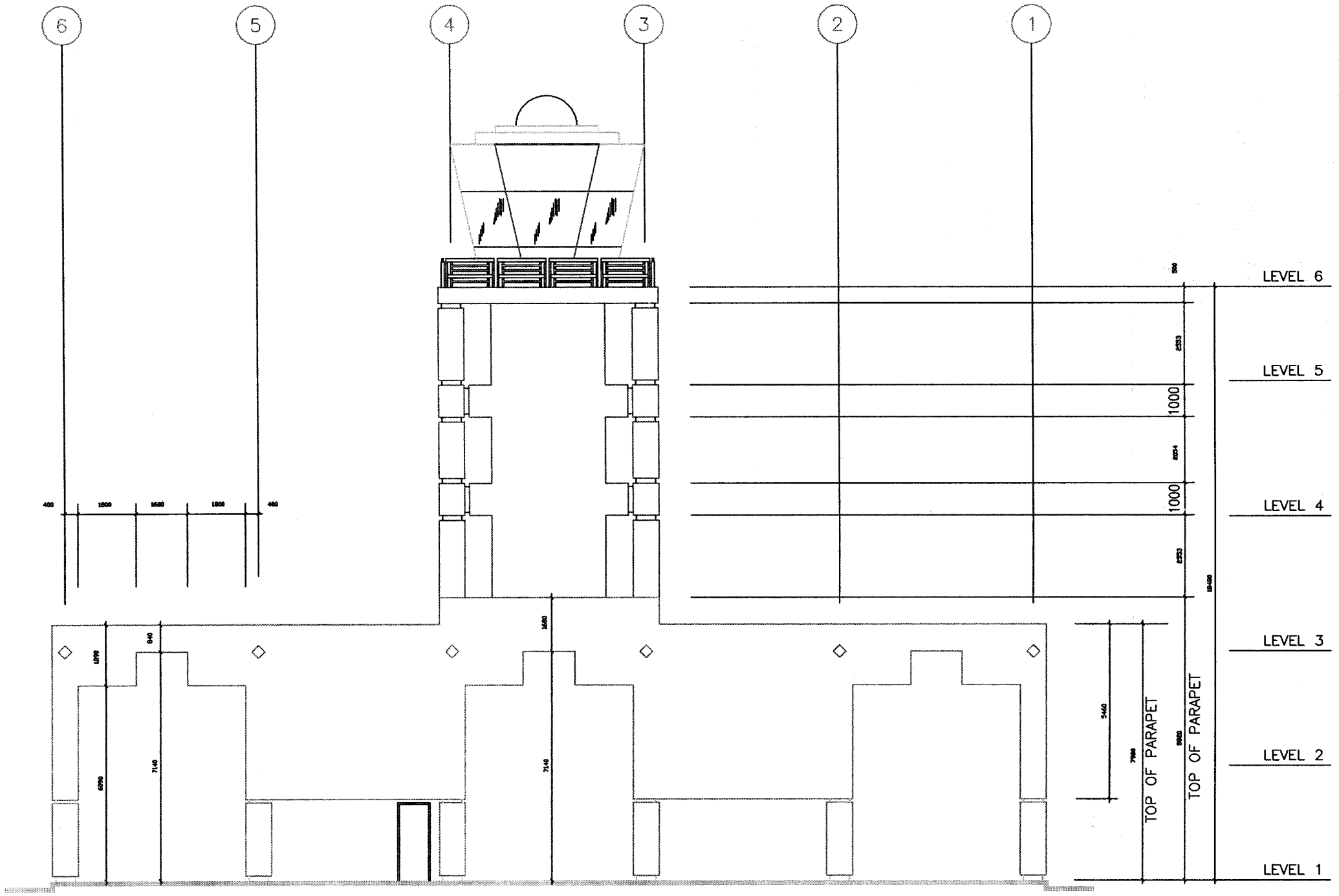
WEB SITE: WWW.AAROTEC.COM
E-MAIL: AAROTEC@AAROTEC.COM

DESIGNED	DRAWN	CHECKED	APPROVED	APPROVED
C.M.	ILA	ACY		
	DATE 10/07	DATE 10/07	DATE	DATE
SCALE	ISSUE DATE	PROJECT No.	SERIES No.	
INDICATED	06/07			

NACALA INTERNATIONAL AIRPORT
NAMPULA PROVINCE
MOZAMBIQUE

ATC BUILDING
FRONT ELEVATION

DRAWING No. ATC03



AIR TRAFFIC CONTROL BUILDING

BACK ELEVATION

REV. No.	DATE	DESCRIPTION	BY	CHECK	APPRO.

AIRPORTS DE MOZAMBIQUE
MAPUTO, MOZAMBIQUE

CONSULTANTS: AAROTEC INFRASTRUCTURE GROUP INC.
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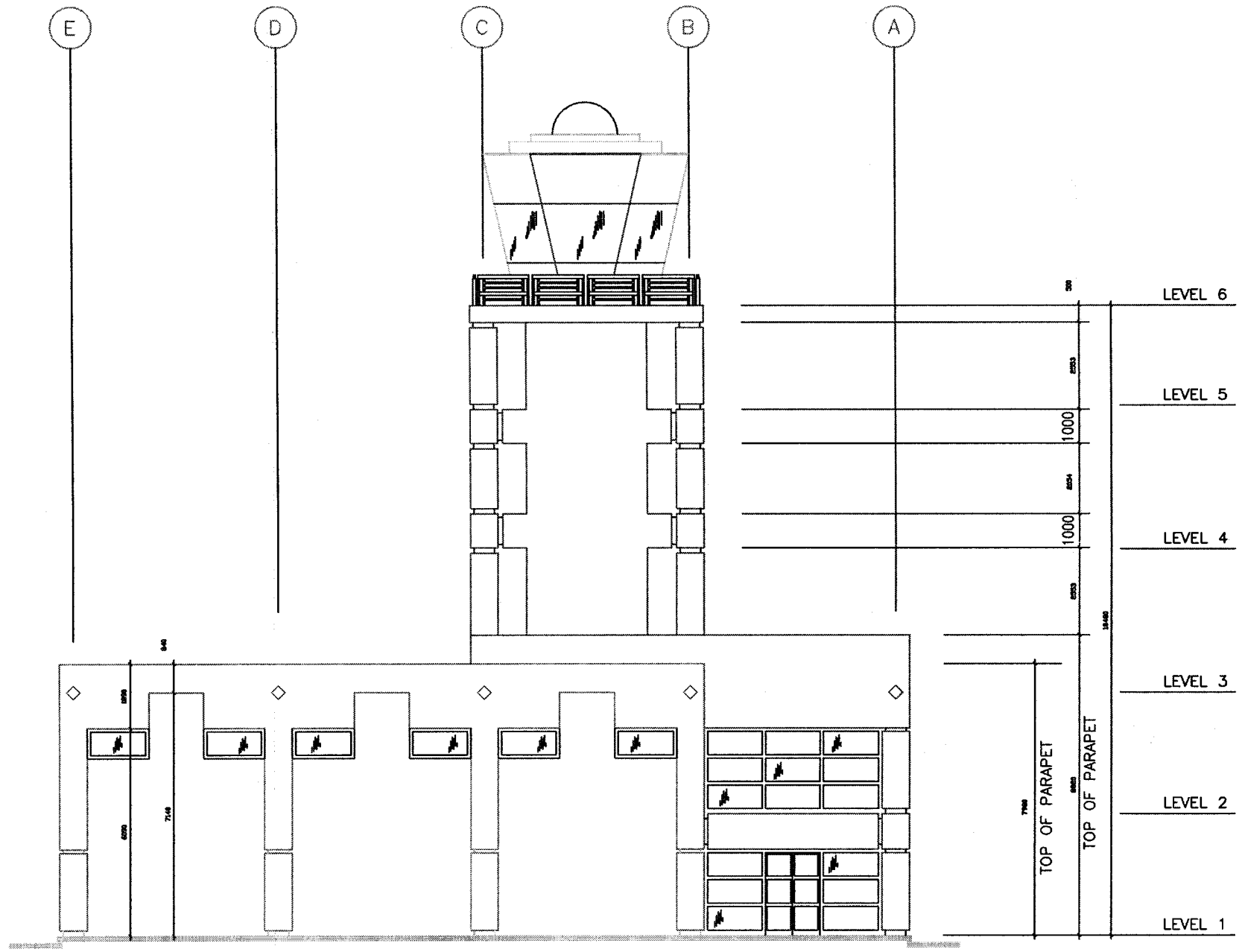
INDICATED	06/07			

NACALA INTERNATIONAL AIRPORT
NAMPULA PROVINCE
MOZAMBIQUE

ATC BUILDING
BACK ELEVATION

DRAWING No. ATC04



AIR TRAFFIC CONTROL BUILDING

SIDE ELEVATION

REV. No.	DATE	DESCRIPTION	BY	CHECK	APRO.

AIRPORTS DE MOZAMBIQUE

MAPUTO, MOZAMBIQUE

CONSULTANTS: AAROTEC INFRASTRUCTURE GROUP INC.
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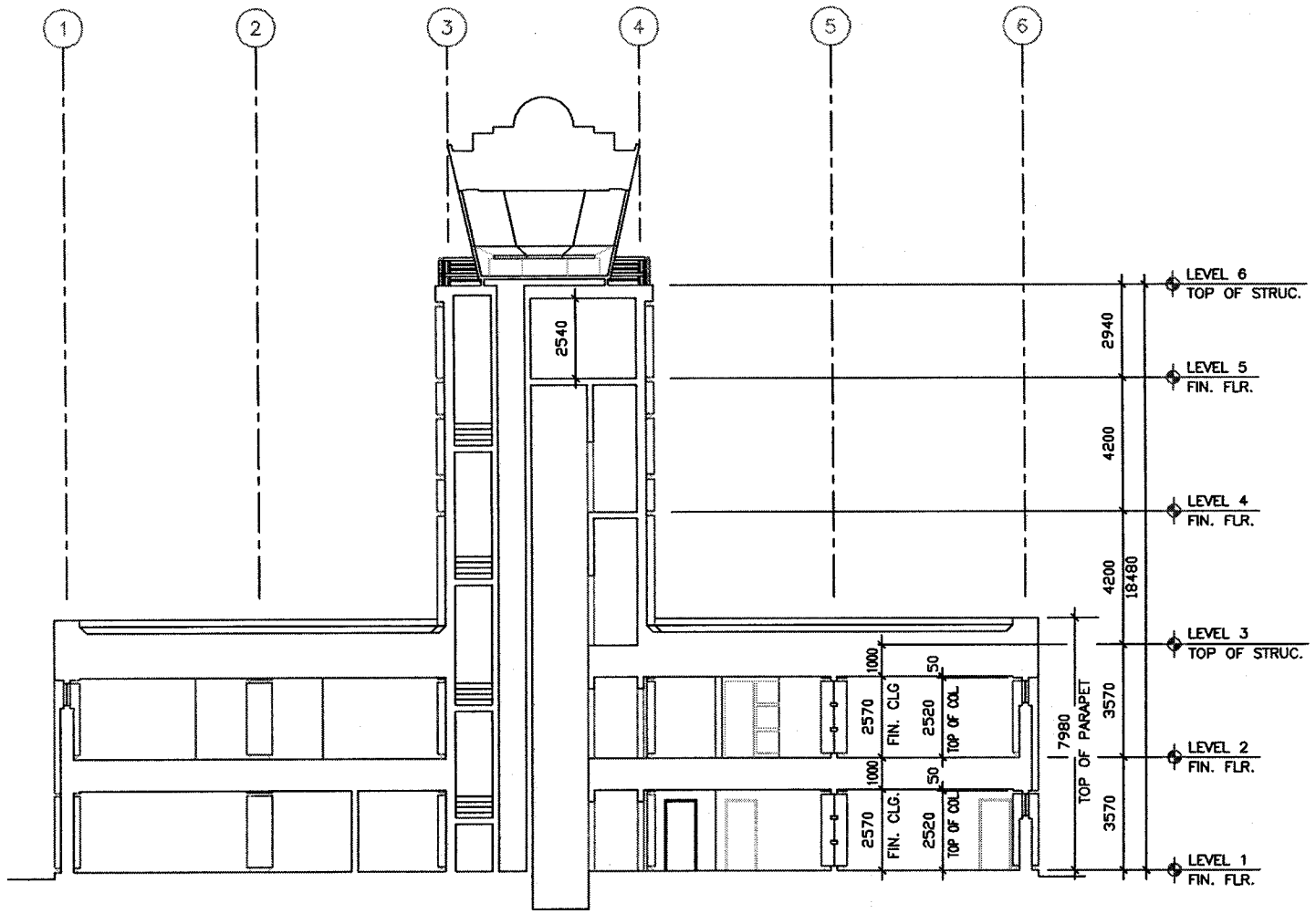
INDICATED	06/07			

NACALA INTERNATIONAL AIRPORT
NAMPULA PROVINCE
MOZAMBIQUE

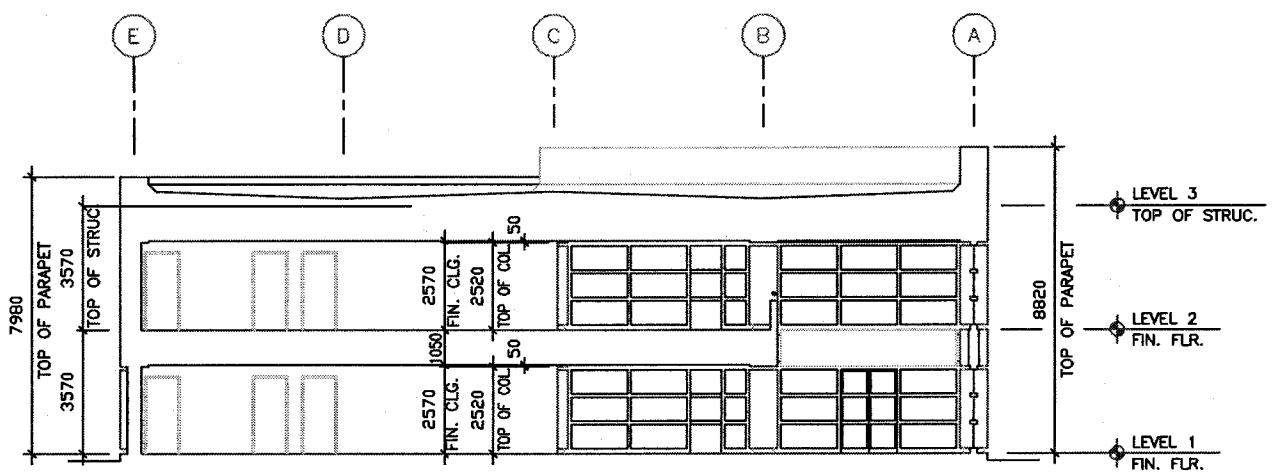
ATC BUILDING
SIDE ELEVATION

DRAWING No. ATC05



ATC BUILDING

SECTION A



ATC BUILDING

SECTION B

REV. No.	DATE	DESCRIPTION	BY	CHECK	APRO.

AIRPORTS DE MOZAMBIQUE

MAPUTO, MOZAMBIQUE

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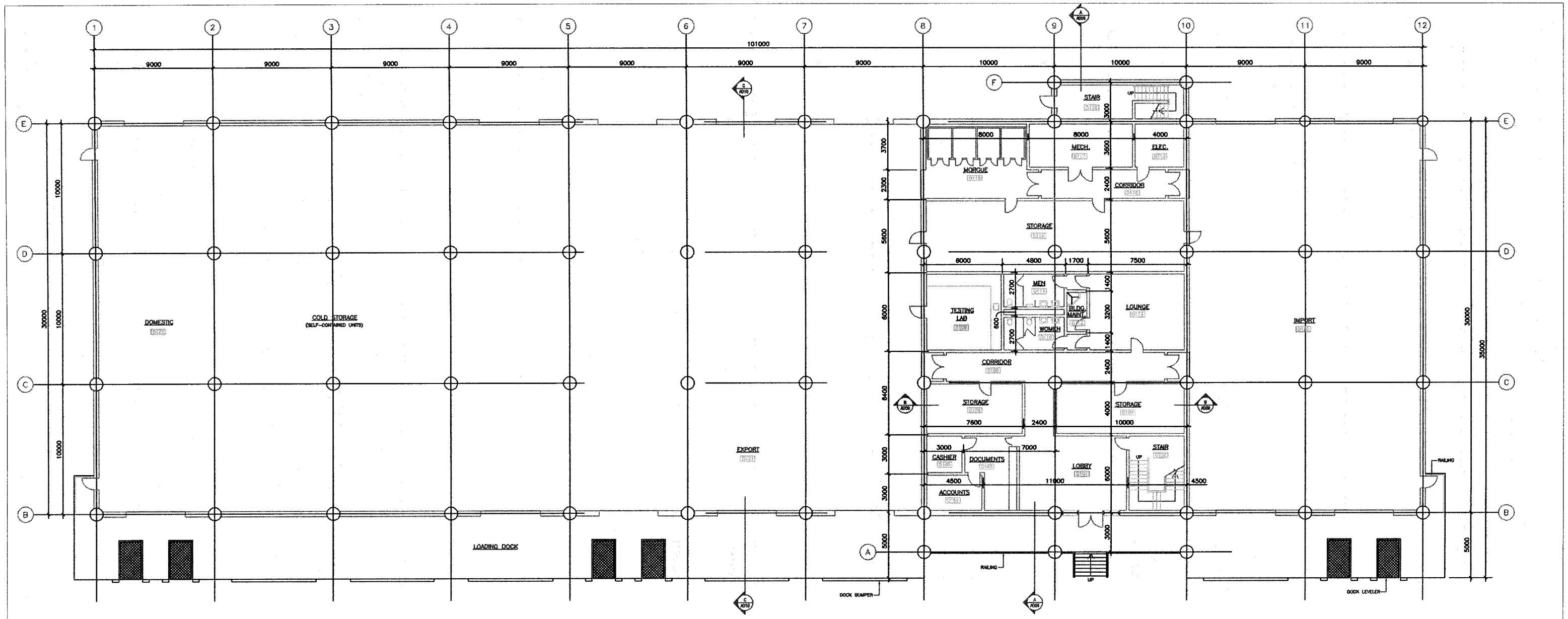
NACALA INTERNATIONAL AIRPORT
NAMPULA PROVINCE
MOZAMBIQUE

ATC BUILDING
CROSS SECTIONS

DRAWING No. ATC 06



LEVEL 1

CARGO TERMINAL FLOOR PLANS

REV. No.	DATE	DESCRIPTION	BY	CHECK	APRO.

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MAPUTO, MOZAMBIQUE

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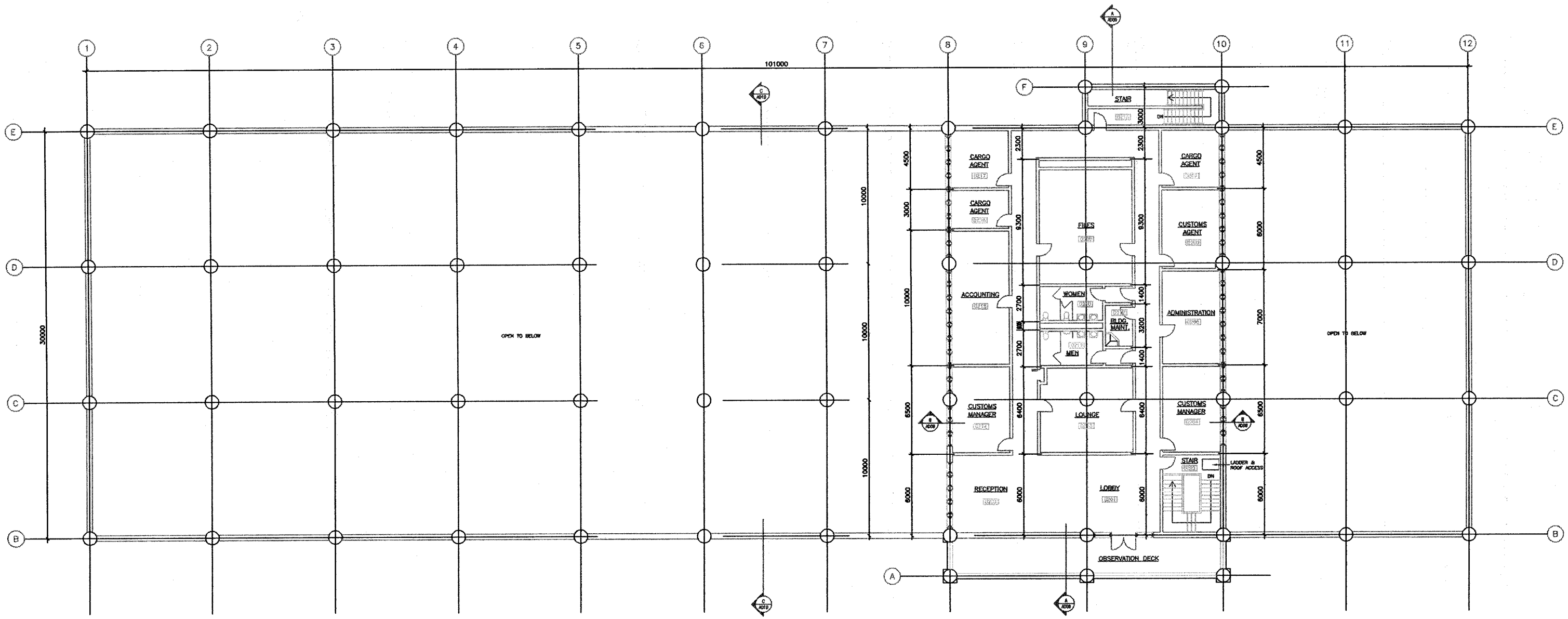
NACALA INTERNATIONAL AIRPORT
NAMPULA DISTRICT
MOZAMBIQUE

CARGO BUILDING FLOOR PLAN
LEVEL 1
DRAWING No. C 01



LEVEL 2

CARGO TERMINAL FLOOR PLANS

REV. No.	DATE	DESCRIPTION	BY	CHECK	APRO.

AIRPORTS DE MOZAMBIQUE
MAPUTO, MOZAMBIQUE

CONSULTANTS: AAROTEC INFRASTRUCTURE GROUP INC.
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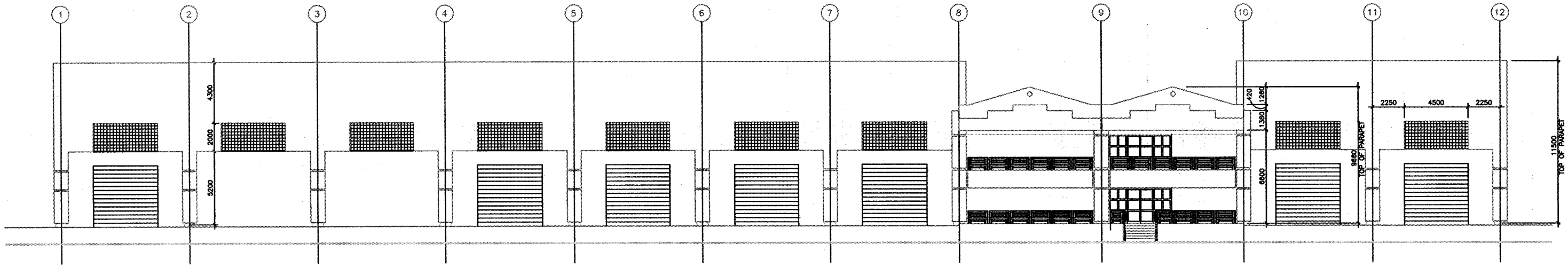
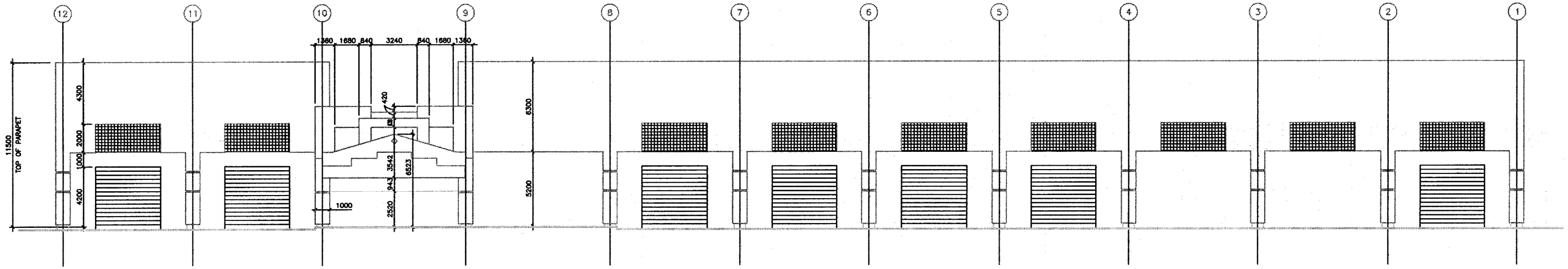
NACALA INTERNATIONAL AIRPORT
NAMPULA DISTRICT
MOZAMBIQUE

CARGO BUILDING FLOOR PLAN
LEVEL 2

DRAWING No. C 02



CARGO BUILDING FRONT ELEVATION



CARGO BUILDING BACK ELEVATION

REV. No.	DATE	DESCRIPTION	BY	CHECK	APRO.

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MAPUTO, MOZAMBIQUE

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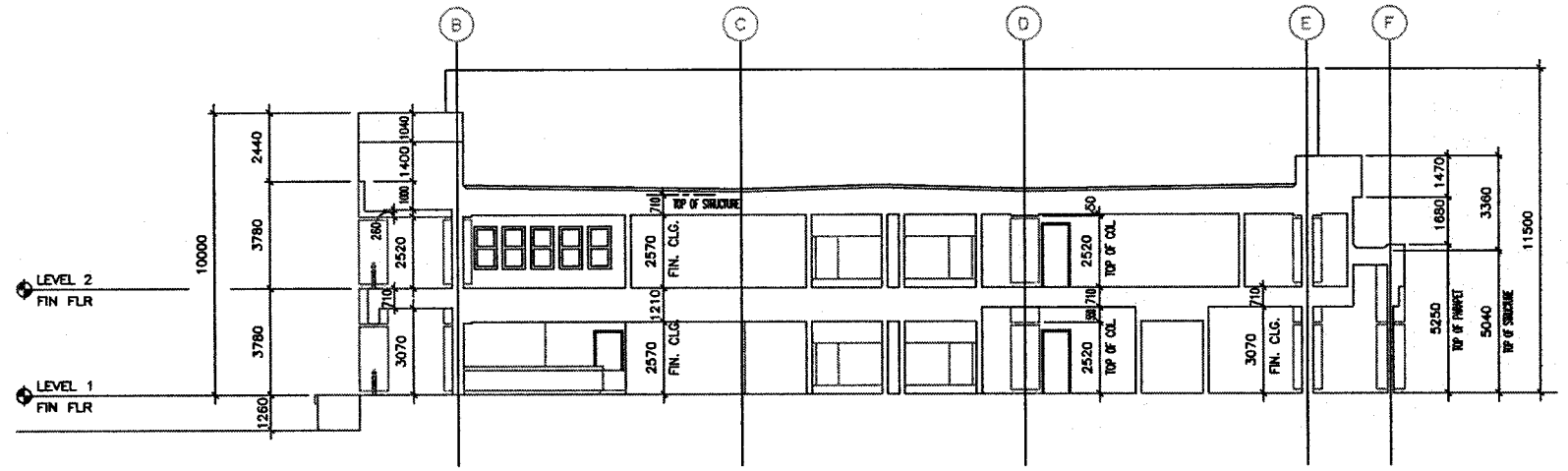
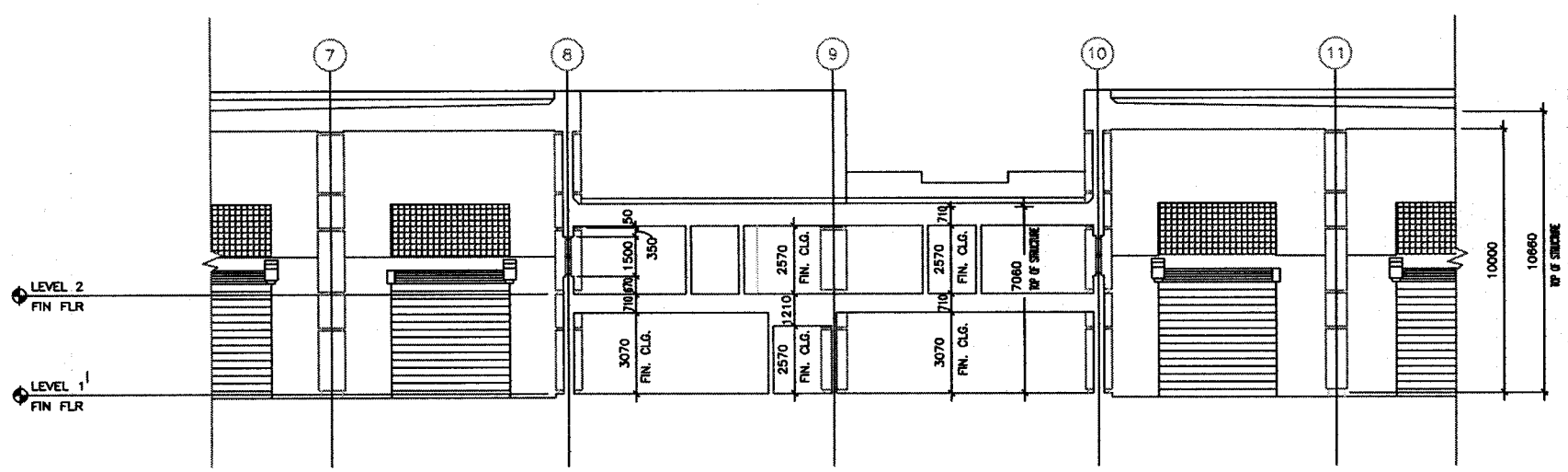
NACALA INTERNATIONAL AIRPORT
NAMPULA DISTRICT
MOZAMBIQUE

CARGO BUILDING ELEVATIONS

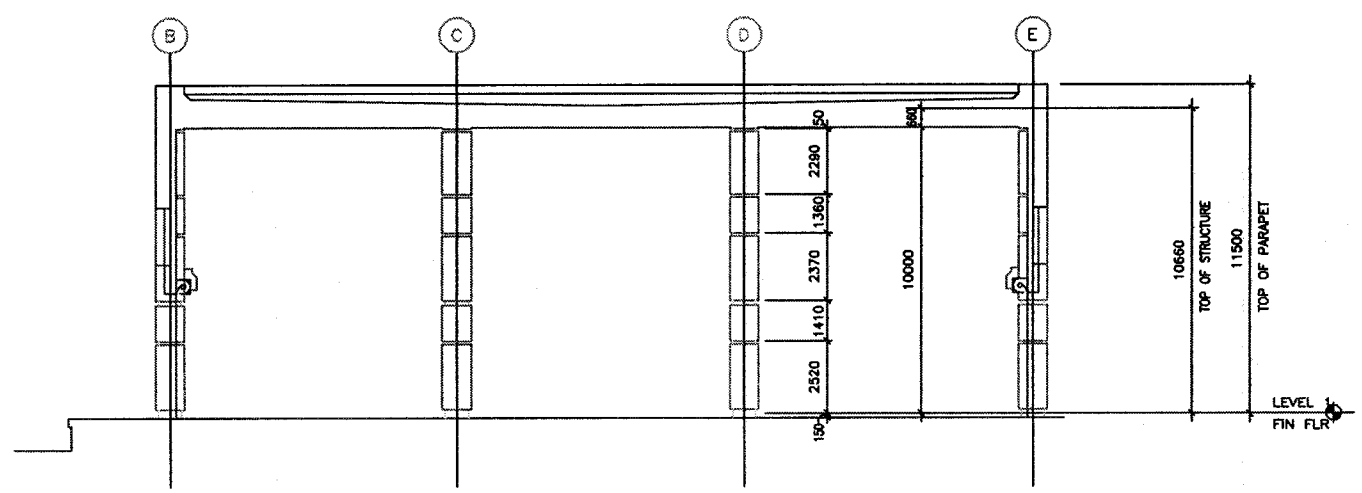
DRAWING No. C 03



SECTION A



SECTION B



SECTION C

REV. No.	DATE	DESCRIPTION	BY	CHECK	APRO.

AIRPORTS DE MOZAMBIQUE
MAPUTO, MOZAMBIQUE

CONSULTANTS: AAROTEC INFRASTRUCTURE GROUP INC.
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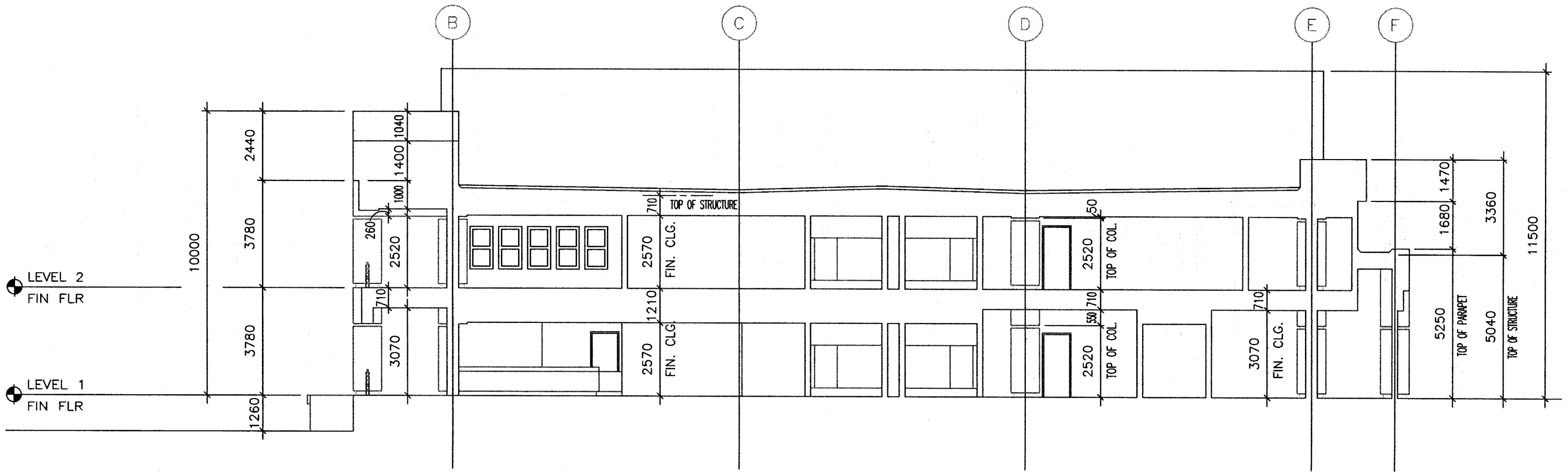
NACALA INTERNATIONAL AIRPORT
NAMPULA DISTRICT
MOZAMBIQUE

CARGO BUILDING
SECTIONS A–B–C

DRAWING No. C 04



SECTION A

REV. No.	DATE	DESCRIPTION	BY	CHECK	APRO.

AIRPORTS DE MOZAMBIQUE
MAPUTO, MOZAMBIQUE

CONSULTANTS: AAROTEC INFRASTRUCTURE GROUP INC.
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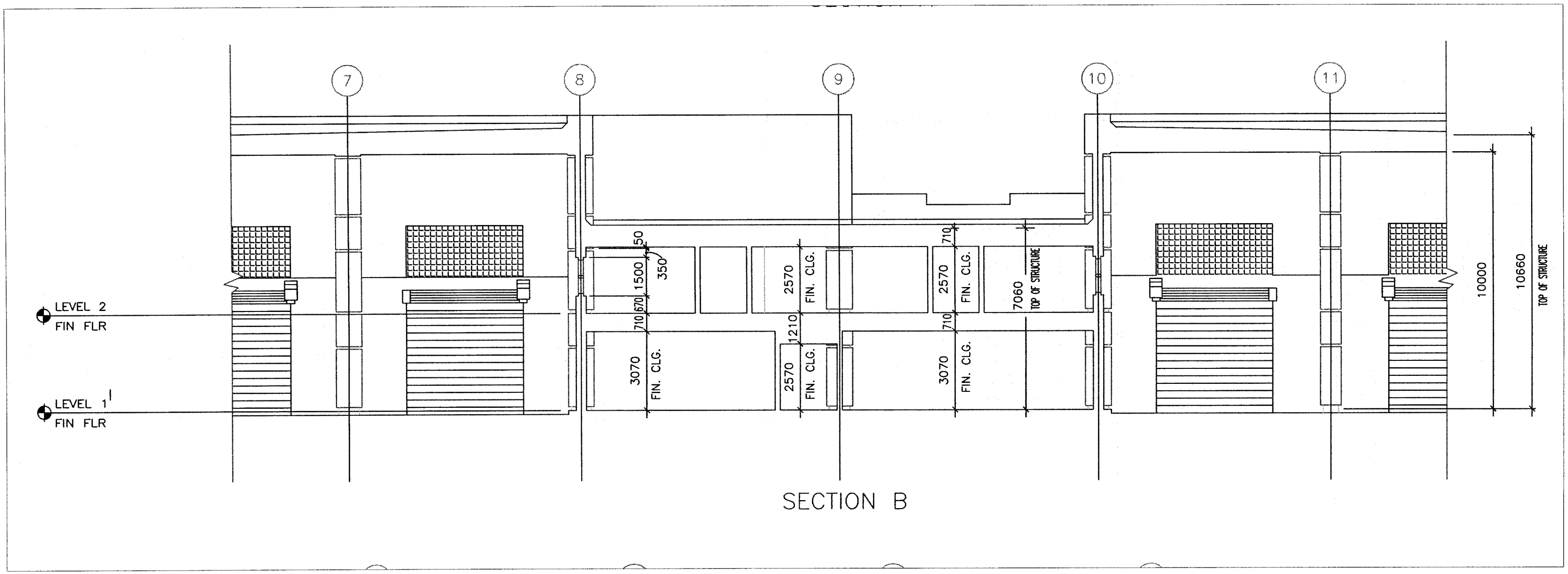
NACALA INTERNATIONAL AIRPORT
NAMPULA DISTRICT
MOZAMBIQUE

CARGO BUILDING SECTION A

DRAWING No. C 05



SECTION B

REV. No.	DATE	DESCRIPTION	BY	CHECK	APRO.

AIRPORTS DE MOZAMBIQUE
MAPUTO, MOZAMBIQUE

CONSULTANTS: AAROTEC INFRASTRUCTURE GROUP INC.
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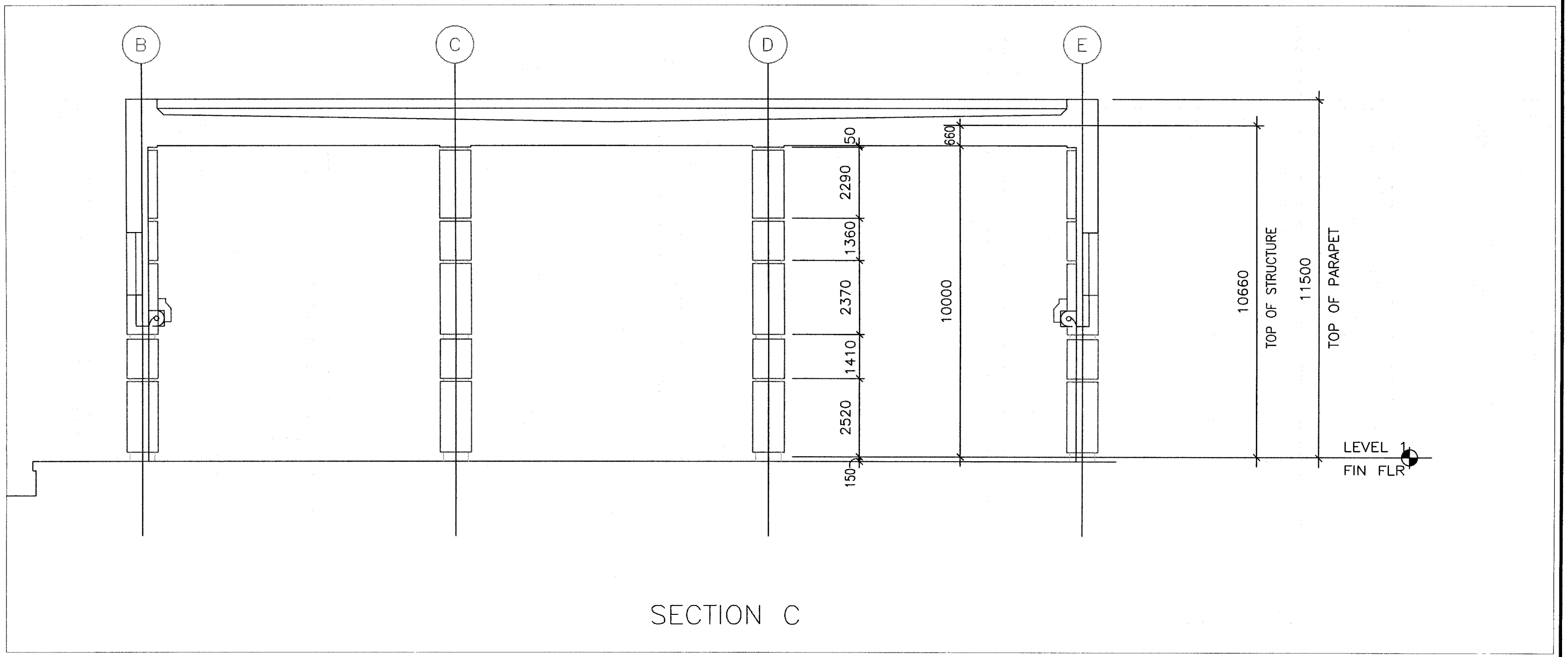
INDICATED	06/07	8028		

NACALA INTERNATIONAL AIRPORT
NAMPULA DISTRICT
MOZAMBIQUE

CARGO BUILDING SECTION B

DRAWING No. C 06



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AIRPORTS DE MOZAMBIQUE
MAPUTO, MOZAMBIQUE

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NACALA INTERNATIONAL AIRPORT
NAMPULA DISTRICT
MOZAMBIQUE

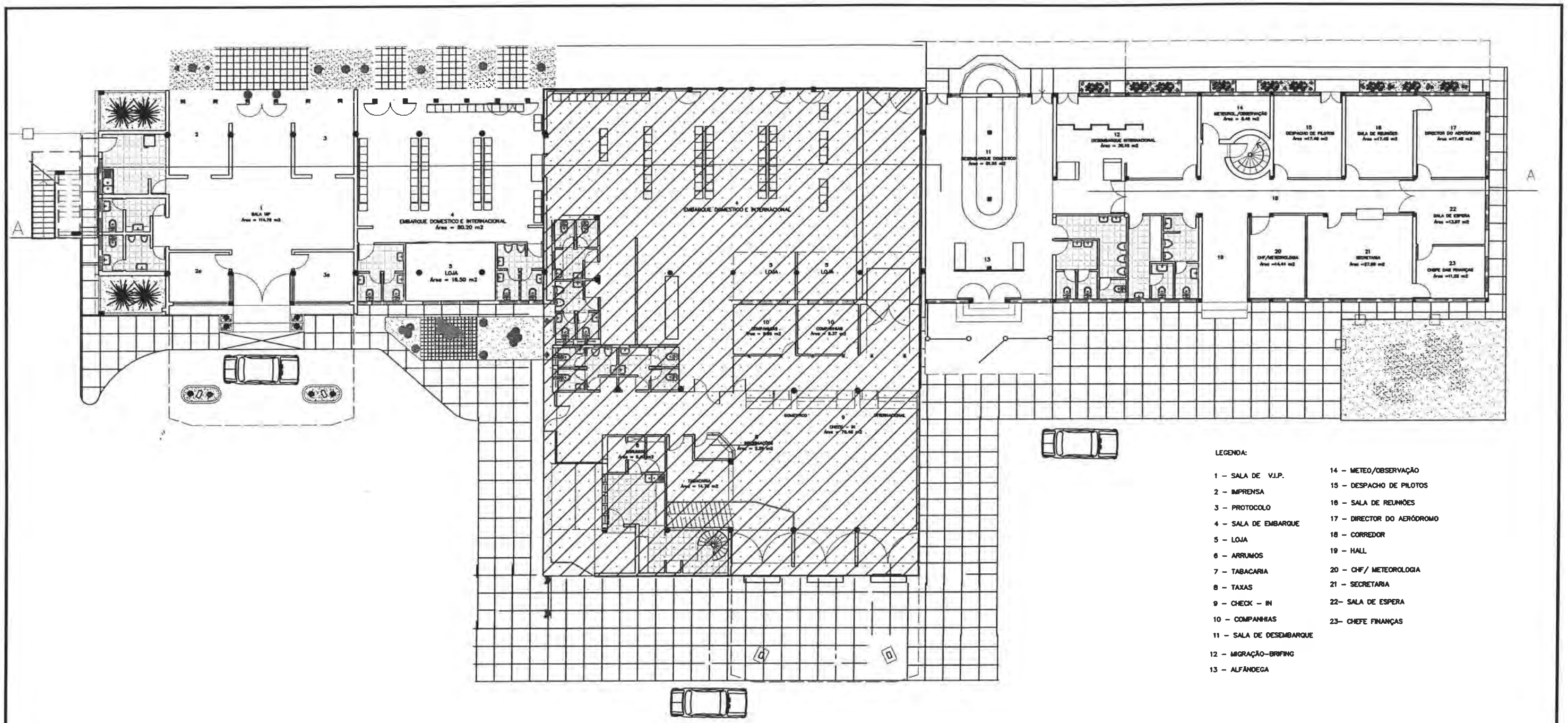
CARGO BUILDING SECTION C

DRAWING No. C 07

PEMBA AIRPORT
CABO DELGADO PROVINCE, MOZAMBIQUE

INDEX PAGE FOR AutoCAD DRAWINGS

Pemba Passenger Terminal Expansion-Phase One	AA01-P1
Pemba Passenger Terminal Expansion-Phase Two	AA01-P2
Airport Layout Plan	AA01-P3
Terminal Area Plan	AA01-P4



LEGENDA:

1 – SALA DE V.I.P.
2 – IMPRENSA
3 – PROTOCOLO
4 – SALA DE EMBARQUE
5 – LOJA
6 – ARRUMOS
7 – TABACARIA
8 – TAXAS
9 – CHECK – IN
10 – COMPANHIAS
11 – SALA DE DESEMBARQUE
12 – MIGRAÇÃO–BRIFING
13 – ALFÂNDEGA
14 – METEO/OBSERVAÇÃO
15 – DESPACHO DE PILOTOS
16 – SALA DE REUNIÕES
17 – DIRECTOR DO AERÓDROMO
18 – CORREDOR
19 – HALL
20 – CHF/ METEOROLOGIA
21 – SECRETARIA
22– SALA DE ESPERA
23– CHEFE FINANÇAS

PEMBA PASSENGER TERMINAL
PROPOSED RENOVATION AND EXPANSION AREA
APPROXIMATE AREA ADDED: 320M2

REV. No.	DATE	DESCRIPTION	BY	CHECK	APPRO.

AIRPORTS DE MOZAMBIQUE
MAPUTO, MOZAMBIQUE

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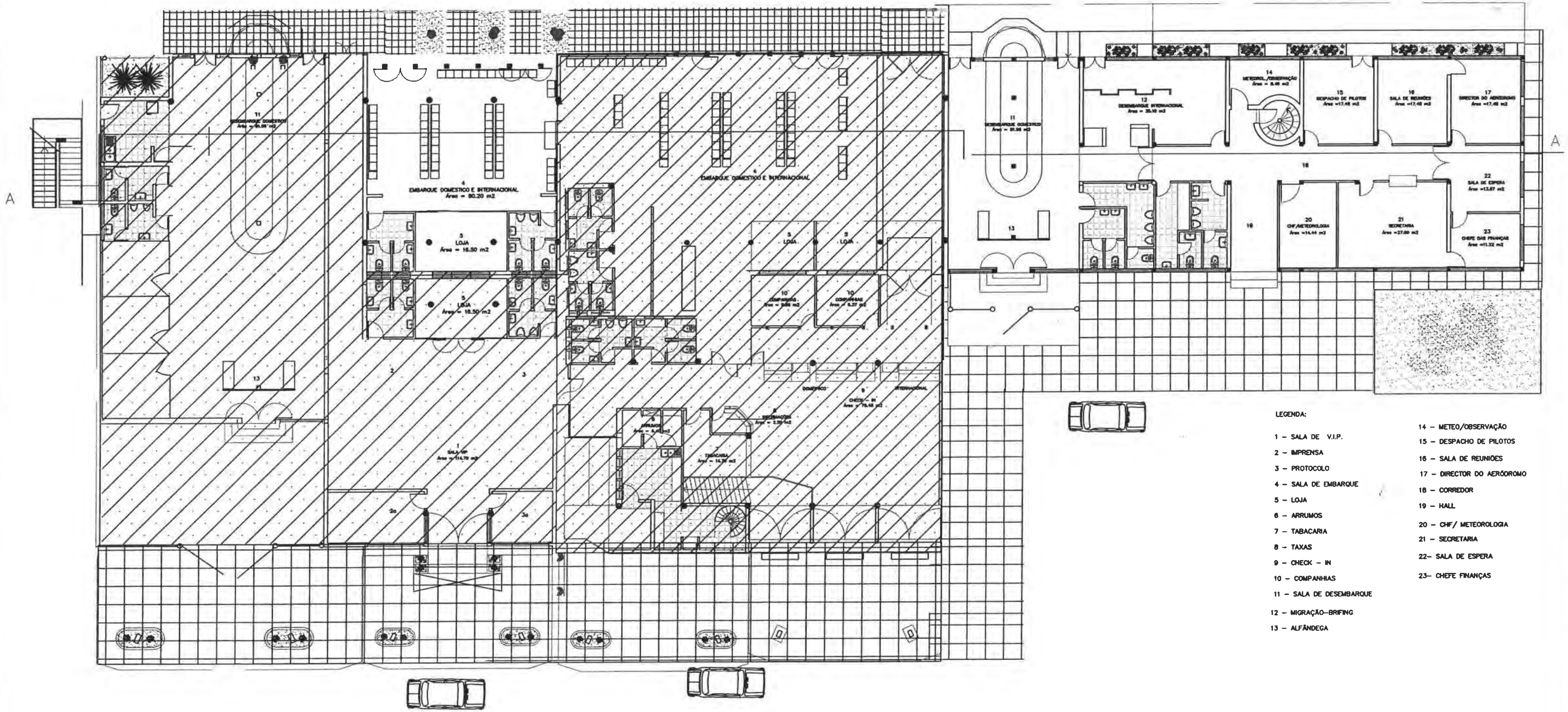
PEMBA AIRPORT
CABO DELGADO PROVINCE

PEMBA PASSENGER TERMINAL
EXPANSION- PHASE ONE
DRAWING No. AA01-P1



LEGENDA:

1 – SALA DE V.I.P.
2 – IMPRENSA
3 – PROTOCOLO
4 – SALA DE EMBARQUE
5 – LOJA
6 – ARRUMOS
7 – TABACARIA
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19 – HALL
20 – CHF/ METEOROLOGIA
21 – SECRETARIA
22– SALA DE ESPERA
23– CHEFE FINANÇAS

PEMBA PASSENGER TERMINAL

PHASE 1 PROPOSED RENOVATION AND EXPANSION AREA

PHASE 2 PROPOSED RENOVATION AND EXPANSION AREA

APPROXIMATE AREA ADDED: 320M2 PHASE 1

APPROXIMATE AREA ADDED: 320M2 PHASE 2

REV. No.	DATE	DESCRIPTION	BY	CHECK	APRO.

AIRPORTS DE MOZAMBIQUE
MAPUTO, MOZAMBIQUE

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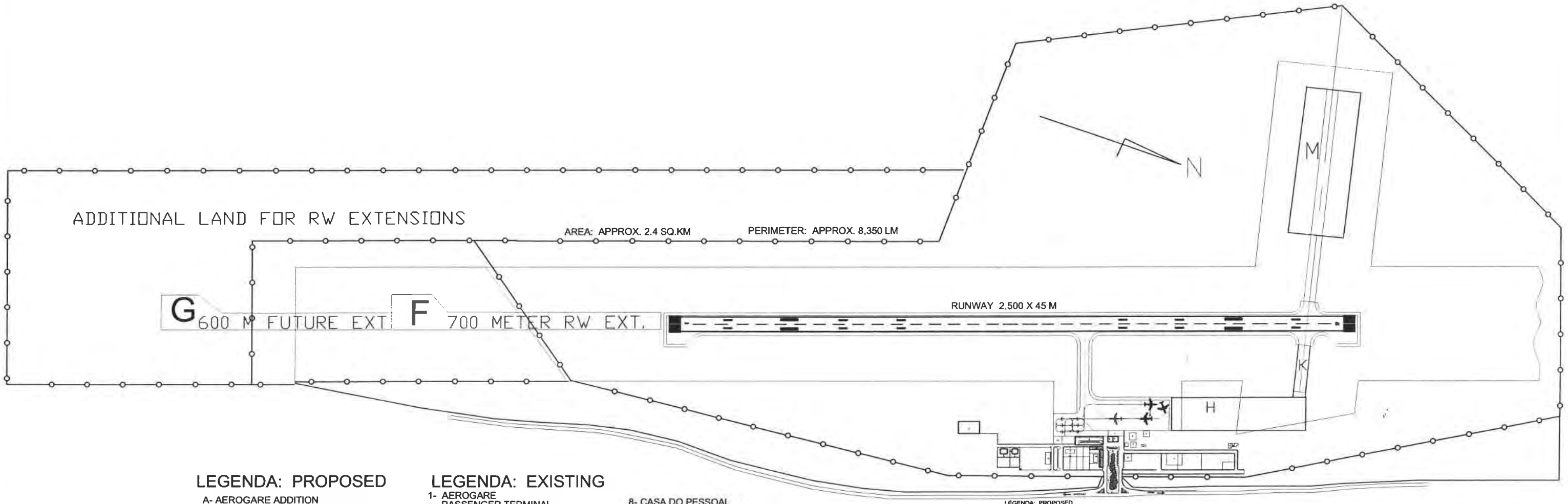
PEMBA AIRPORT
CABO DELGADO PROVINCE

PEMBA PASSENGER TERMINAL
EXPANSION- PHASE TWO

DRAWING No. AA01-P2



LEGENDA: PROPOSED

A- AEROGARE ADDITION
PASSENGER TERMINAL ADDITION
B- AEROGARE ADDITION
PASSENGER TERMINAL ADDITION
C- PARQUE AUTOMÓVEL 16 STALLS
AUTOMOBILE PARKING 16 STALLS
D- PARQUE AUTOMÓVEL 9 STALLS
AUTOMOBILE PARKING 9 STALLS
E- PARQUE AUTOMÓVEL 45 STALLS
AUTOMOBILE PARKING 45 STALLS
F- RUNWAY EXTENSION
RUNWAY EXTENSION
G- RUNWAY EXTENSION
EXTENSÃO DA PISTA DE DECOLAGEM
H- ADDITIONAL RAMP AREA
ÁREA ADICIONAL DO RAMPA
K- TAXILANE TO RAMP AREA
TAXILANE Á ÁREA DA RAMPA
M- LONGTERM AIRCRAFT PARKING
EXTACIONAMENTO A LONGO PRAZO DOS AVIÕES

LEGENDA: EXISTING

1- AEROGARE
PASSENGER TERMINAL
2- QUARTEL DE BOMBEIROS
FIRE & RESCUE BLDG
3- TERMINAL DE CARGA
CARGO TERMINAL
4- HANGAR
HANGAR
5- CENTRAL ELÉCTRICA
ELECTRICAL CONTROL BUILDING
6- MOTI RENT A CAR
CAR RENTAL
7- GASOLINEIRAS
FUEL STORAGE
8- CASA DO PESSOAL
PERSONNEL HOUSING
9- PARQUE AUTOMÓVEL
AUTOMOBILE PARKING
10- CASA DE TRÂNSITO
COMMERCIAL BUILDING
11- CASA GEMINADA
MANAGEMENT HOUSING
12- AEROCLUBE
GENERAL AVIATION
13- ZONA OFICINAL
ZONA OFICINAL
14- CASAS DA METEOROLOGIA
METEOROLOGIA HOUSING
15- ARMAZÉM DA METEOROLOGIA
ARMAZÉM DA METEOROLOGIA

NOTE:

AREA: APPROX. 2.4 SQ.KM

PERIMETER: APPROX. 8,350 LM

REV. No.	DATE	DESCRIPTION	BY	CHECK	APRO.

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MAPUTO, MOZAMBIQUE

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PEMBA AIRPORT

CABO DELGATO PROVINCE

AIRPORT LAYOUT PLAN

DRAWING No. AA01-P3