

Miami International Airport (MIA) – Overcoming Challenges Related To Huge Capital Improvement Programs

Daniel J McFadden ⁽¹⁾, P.E. (Primary Contact)
Juan Carlos Arteaga ⁽²⁾, AIA, NCARB, CBO, CGC, LEED AP

- (1) Associate Principal, Lea+Elliott, Inc., 5200 Blue Lagoon Drive, Suite 250, Miami, FL 33126; PH 305 500 9390; Fax 305 500 9391; dmcfadden@leaelliott.com
(2) NTD Program Director, Miami Dade Aviation Department, P. O. Box 025504, Miami, FL 33102; PH 305 869 5694; Fax 305 876 7067; jcarteaga@miami-airport.com

Abstract

Miami International Airport (MIA) is a large international hub airport and the gateway that welcomes South American, Central American and Caribbean visitors to the United States. Conveniently located within five miles (8.05 km) of downtown Miami, MIA is the single largest economic engine for the South Florida area. MIA's \$6.2 billion expansion program is the largest construction program at an operating airport. The overall expansion program known as the North Terminal Development (NTD) Program includes expansion of the Terminals A through D and a new APM System which consists of four passenger stations (1 through 4) serving Gates D1-D60 of Concourse D at Miami International Airport. The APM System will be located on the fourth level of the terminal building, with the pinched loop guideway alignment running over the roof of the facility between the four stations and the Maintenance & Storage Facility (M&SF). The operation of the system can be best visualized as a continuous loop, in which driverless trains will automatically follow each other in a synchronous manner. The M&SF, Central Control room and administrative offices for the APM system are located in a consolidated facility south of Station 3.

Many challenges were faced with such a large Capital Improvement Program including integrating the fixed facilities with the new Baggage Handling System and new rooftop APM System and dealing with extended construction periods. This paper will focus on and discuss these challenges and specifically identify how these challenges were successfully overcome with the APM System. This will include successful negotiating strategies, dealing with expired warranty issues, maintenance of manufactured equipment and trains during extended construction periods and challenges encountered and addressed during testing and commissioning. The paper will also address continuously evolving planning and design issues that are challenging today's airport managers, architects, and engineers as a result of local and global events within the past two decades that have impacted the airports safety and security needs, building design and airport connectivity to the city.

North Terminal Development (NTD) Program

In 1989, American Airlines made a decision to schedule traffic from its large domestic US route system through MIA and into the Caribbean and Central/South America. The implementation of that strategy resulted in the creation of an international passenger and cargo-connecting hub in MIA that has continued to grow over time. The North Terminal Development (NTD) Program evolved in response to that growth and to the strong corporate commitment to improve the overall level of service throughout Miami International Airport's passenger terminal.



Photo 1 – Night View of North Terminal D Concourse Gates

Photo courtesy of Miami Dade Aviation Department

American Airlines, planners from the Miami-Dade Aviation Department and a team of consultants, worked together to plan the NTD Program. The program's planners focused on creating wide-body gates for international aircraft, relieving congestion in the terminal and concourse areas, and increasing the Airport's capacity for processing international arriving passengers. One of the greatest challenges that faced those planners was the development of a design and a construction plan that would satisfactorily address the complex phasing, scheduling and coordination issues associated with maintaining the existing 42-gate operation while minimizing the disruption to the ongoing passenger and baggage operations. The program that resulted from those planning efforts calls for the reconfiguration, removal and or replacement of over one-half of the existing terminal area (spanning between Terminals A and D). The new terminal facility will allow the Airport to offer higher levels of passenger service, comfort and convenience; minimize passenger and

baggage connect times; provide opportunities for future gate expansions; and integrate its commuter airline operation.

The new 48-gate (plus two contact gates for the RCF) NTD facility will be capable of accommodating fully independent domestic and international arrivals at each gate. The new Regional Commuter Facility (RCF) was constructed at the west end of the NTD complex and it has been in operation since August 2010. That facility (as reflected in the current NTD Master Plan) will combine a passenger loading bridge and business operation. It has 2 full contact gates plus 12 hard stand positions with ramps. See Figure 1 below.

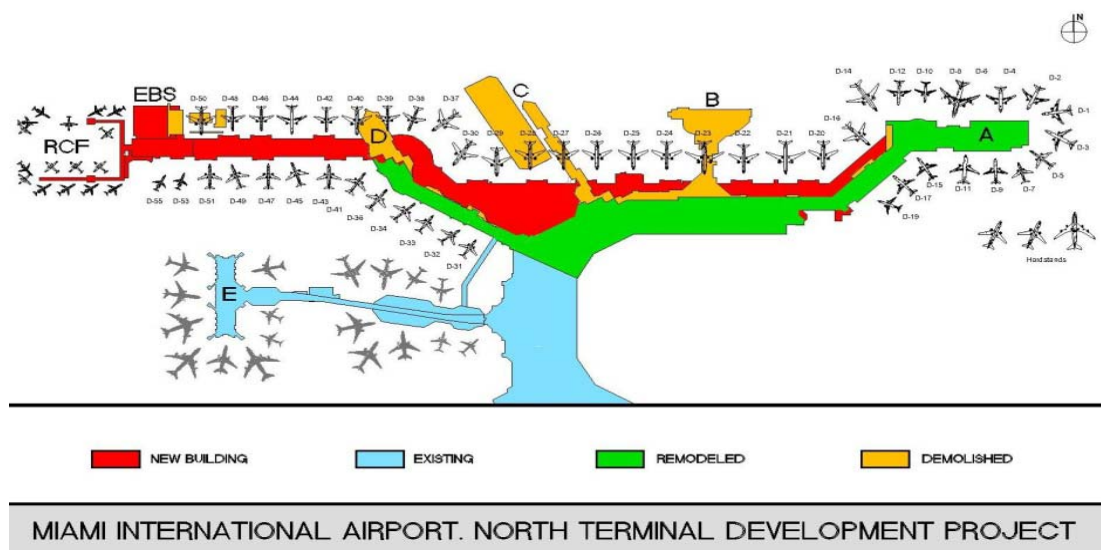


Figure 1. MIA North Terminal Development Project

The building's design involves weaving new and existing structures and systems into an integrated complementary architectural expression. The total program area planned is more than 3,600,000 ft², of which 1,900,000 ft² is new construction while the balance of the area is to be renovated. The North Terminal stretches over 1.1 miles (1.77 km), creating a linear concourse that incorporates the recently renovated Concourse A, utilizes a portion of the existing Concourse D and extends that concourse westward. The demolition of Concourses B, C and portions of D also permitted the addition of a third taxi lane and an aircraft push-back zone on the north side of the terminal parallel to Runway 9L/27R thus permitting more efficient airfield movement for a hub operation. Additionally, the westward expansion of Concourse D was planned to permit a dual taxi lane in the aircraft "alley" between Concourses D and E. Figure 2 below provides all the facts and scheduled completion dates for the North Terminal Development Program.

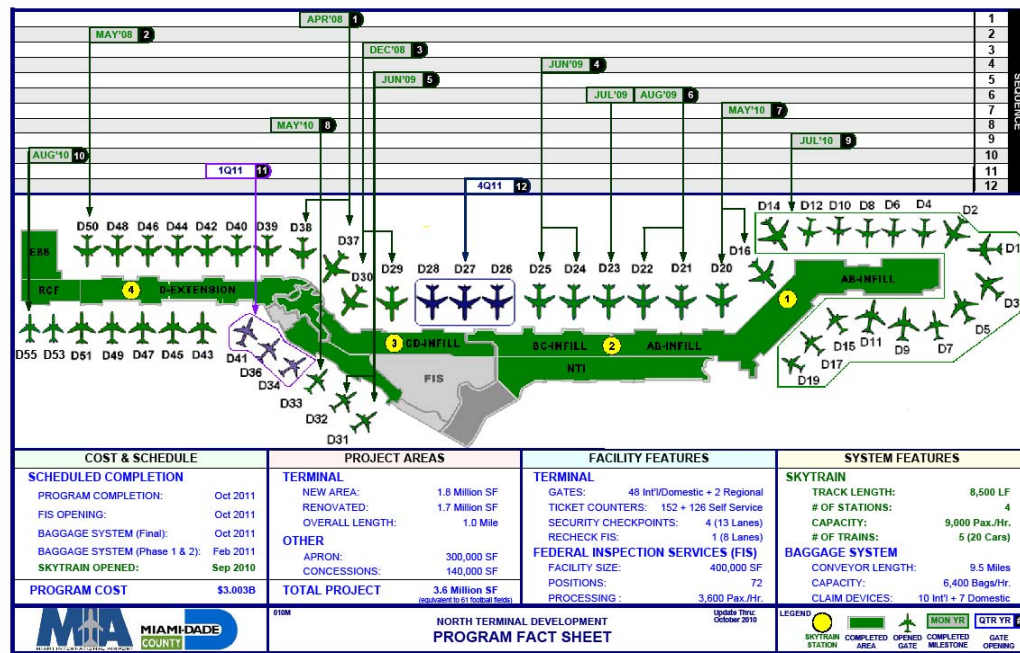


Figure 2. NTD Fact Sheet

To make the passengers' connection to their next flight more convenient, an Automated People Mover (APM) has been constructed on the roof-level of the facility and designed with a pinched-loop alignment. The APM system, described in later sections in detail, has five four-car trains that operate in a synchronized continuous loop timed to maintain a 120-second headway, which provides a capacity of 9,000 riders per hour. Escalators, elevators and moving walkways were also installed to lessen the passenger's unassisted walking distance.

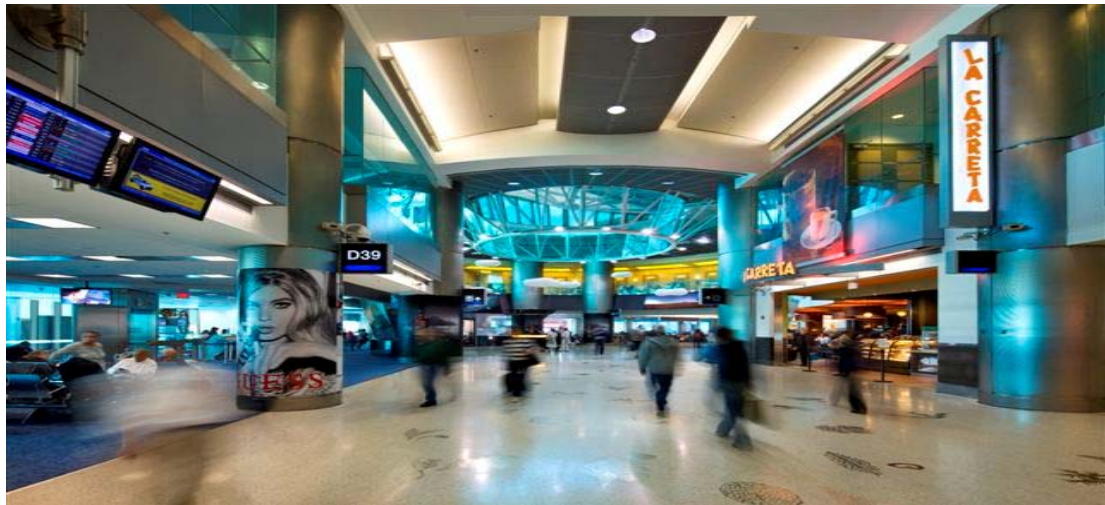


Photo 2 – Inside View of North Terminal D Concourse

Photo courtesy of Miami Dade Aviation Department

Efficient airline hubs require operational scheduling within small windows of time. This compression causes extreme peak demand on terminal systems. For this reason,

the selection of a baggage handling system and the connection of the passengers and their baggage was a major design consideration. The program has been significantly impacted by preliminary TSA requirements and changes to allow 100% baggage screening and to comply with the new screening protocols. However; all necessary changes have been incorporated and TSA testing for phase 1 and 2 of the system is to begin in November 2010.

The NTD is a multi-phased construction program that has been scheduled to avoid interruption to American Airlines' operation. During the first four years, the program was segregated into 35 separate design packages and 84 individual and distinct construction packages.



Photo 3 – North Terminal Rotunda & Food Court

Photo courtesy of Miami Dade Aviation Department

The North Terminal Program has won a number of awards and recognitions, including but not limited to: Best 2010 Vertical Transportation Project (Engineering News records); Top 15 Most Noteworthy World Airports (Passenger Terminal World Annual Review); 2010 Best Food Court Award (News Miami); among others.

The Program faced many challenges from its original design to its final implementation. The first challenge was facing the initial budget which was roughly a third of the actual amount needed for successful completion. Another big challenge was proper inter-phasing of the myriad of projects and systems needed for an airport operations; such as the 10 mile (16 km) long Baggage Handling System with 5 security matrices and 25 EDS machines; the 1.6 mile (2.6 km) long Automated People Mover (APM) located on the roof of the building, among others.

The NTD Program was then split into several design/construction packages that are defined in Table 1 below.

Table 1. NTD Design/Construction Packages

Project#	747B	745B/ 746A	739A	741A/ 739F	761A	740A	737G/E	739C	756A/D
Name	A-B Infill	B-C Infill	C-D Infill	D-Extension	RCF	FIS Facility	C-D Infill Shell	D-Remodel	NTI
Area	New-280,000 Remodel- 100,000	New-250,000 Remodel- 173,000	Finishes- 237,000	New-450,000	New-65,000	Finishes- 400,000	New-775,000	Remodel- 221,000	Remodel- 310,000
Cost (in \$M)	369.9	192.9	66.1	133.7	41.6	155.6	163.5	87.0	155.8
A/E of Record	Leo A Daly	Bermello, Ajamil & Partners	Wolberg, Alvarez & Partners	Harper Partners & Perez/Perez	The Russell Partnership	MC Harry Associates	Wolberg Alvarez & Partners	Wolberg, Alvarez & Partners	Rodriguez & Quiroga
MEP	TLC Engineering	Fraga Engineers	Wolberg, Alvarez & Partners	1)Hufsey, Nicol aides,Garcia,S uarez, 2)SDM, 3)Hammond & Associates	SDM Consulting Engineers	Luis J Aguirre & Associates	Wolberg Alvarez & Partners	Hammond & Associates	Johnson, Avedan o, Lopez, Rodrigu ez, Walewski
Structural Engineer	TLC Engineering	Donnell Duquesne & Albaisa	Martinez Engineering Group	1)Donnell Duquesne & Albaisa, 2)Martinez Kreh & Associates	Bliss & Nyitray	Martinez Engineering Group	Donnell Duquesne & Albaisa	Martinez Engineering Group	Donnell Duquesne & Albaisa

MIA 739A – CD Infill Interiors

The work comprises the construction of the interior finishes for the new shell structure built north of the existing D Concourse within the footprint of what is commonly referred to as the CD Infill project.

**Photo 4 – D Concourse Art in Public Places**

Photo courtesy of Miami Dade Aviation Department

The approximate area of the 739A Finish-Out Project is approximately 250,000 ft² (23,230 m²). The work requires a high level of coordination to take place between the existing “shell” MEP and FP shell systems and the Finish-Out MEP and FP systems. In addition, close coordination between the existing structure and finishes must take place.

The second level also referred to as “Concourse Level” provides the main access to the Hold rooms. From there, Domestic and International accessibility to boarding gates is provided through a series of secure/sterile corridors that is separated from the concourse by full height butt joint glass wall system. International passengers access the third level sterile circulation by means of vertical circulation cores. An Automated People Mover Station (APM) located on the fifth level provides access for Sterile and Domestic passengers.

MIA 739C – Concourse D Remodel, All Levels

The work is comprised of phased and sequential selective demolition, renovation and related improvements of approximately 200,000 square feet (18,580 m²) of existing space located on Concourse D.

The project consists primarily of interior improvements necessary to update and remodel existing building areas for continued use as an operational airport terminal facility, together with incidental selective demolition and re-construction of existing exterior building envelope components.

The portion of the project area, specifically the third level of the existing facility, and all work relating to this area will be undertaken within “sterile” areas of the Concourse under the direct jurisdiction of the U.S. Customs and Border Patrol.



Photo 5 – D Concourse by Gate D51

Photo courtesy of Miami Dade Aviation Department

MIA 739I – D Remodel, Ramp Level

The work is comprised of selective demolition and renovation of approximately 21,000 square feet (1,951 m²), located on the Ramp level of existing Concourse D.

The project consists primarily of interior renovations necessary to remodel existing building areas for use by American Airlines Ramp Services Fleet Administration, together with incidental selective demolition and re-construction of existing exterior building envelop components.

MIA 740A – Concourse CD FIS

This project consists of the finish-out of three floors of the North Terminal Development Program in Concourse C-D area. Occupying this facility will be Immigration and Naturalization, US Customs, Public Health, US Department of Agriculture, Homeland Security, TSA, MDAD International Operations, and American Airlines International Operations. Work also includes the construction of a passenger exiting ramp between the first and second levels, as well as a first level 8eters/ greeters lobby. This is an approximately 400,000 square foot facility for the processing of international passengers. This number encompasses all associated auxiliary spaces.

- Project encompasses 3 levels of construction
- 3rd level, INS processing hall and associated back-office facilities
- 2nd level, baggage claim area and USCS processing facility
- 2nd level, baggage recheck, recheck counters, security checkpoint
- 1st level, FIS facility exit, meters/greeters lobby, APHIS
- Facility is designed to process 3600 passengers/hour
- 72 INS processing positions and 6 INSPASS kiosks
- 10 International baggage claim units (by others)
- 8 Baggage recheck load belts (by others) and 14 recheck counter positions.
- 6 USCS processing positions
- Secondary processing area utilized by a combination of USCS and APHIS processing personnel.
- Security checkpoint currently 5 lanes, proposed to be 10 lanes due to TSA processing times.



Photo 6 – Full Exterior View of North Terminal D Concourse

Photo courtesy of Miami Dade Aviation Department

MIA 746A – BC Infill Interiors

The work is comprised of the phased and sequential construction of Interior Finishes for a new building shell and for portions of the existing building shell in ramp, concourse and third level areas between the existing Concourse “B” and “C”; installation of some mechanical, electrical, fire protection and plumbing services required for life safety; and some temporary construction as required to facilitate this construction located at the Miami International Airport, Miami, Florida.



Photo 7 – D Concourse by B-C Infill Area

Photo courtesy of Miami Dade Aviation Department

MIA 756A/D - North Terminal Improvements, ATO and Baggage Claim

The work is comprised of general construction of renovations in the existing terminal building located in terminal areas A through D at Miami International Airport for Miami-Dade Aviation Department, the Owner. The project principally includes work on levels 1, 2, 3 and rooftop.

MIA 761A – Regional Commuter Facility Shell and Interior Finish (RCF)

The project provides for the construction of a three story structure with two (2) second level boarding domestic/international gates and a bus station for ground level boarding gates for American Eagle. The facility will also contain support spaces for Eagle operations and concession areas. The project will connect to the new Concourse D Extension, also part of the North Terminal Development Program. The project is located on the West end of the Concourse D Extension and is approximately 68,000 S.F.

MIA 702B – Automated People Mover

The NTD Program includes an Automated People Mover (APM) System. The APM System will be located on the fifth level of the terminal building, with the pinched loop guide way alignment running over the roof of the facility between four stations and the Maintenance & Storage Facility (M&SF). The length of the system is approximately 8500 lineal feet (2987 meters) of guide way.

The entire fleet consists of five 4-Car Trains or 20 cars. The estimated round trip time of the APM system is approximately 8 minutes and the estimated wait time between trains or headway is 2 minutes. The operation of the system can be best visualized as a continuous loop, in which driverless trains will automatically follow each other in a synchronous manner. The M&SF, Central Control room and administrative offices for the APM system are located in a consolidated facility south of Station C.



Photo 8 – Skytrain Station 3 Platform

Photo courtesy of Miami Dade Aviation Department

Miami International Airport's New Skytrain

The new Skytrain at Miami International Airport (MIA) is a driverless Automated People Mover (APM) system. The Skytrain provides passenger conveyance service to four stations serving 50 gates throughout MIA's "D" Concourse. See Figure 3 below. During peak hours the Skytrain operates with four, 4-car trains in a pinched loop configuration along the over 1 mile (1.6 km) dual lane guideway. With approximately 120 second headways, the system can carry nearly 9,000 passengers per hour per direction (pphpd).

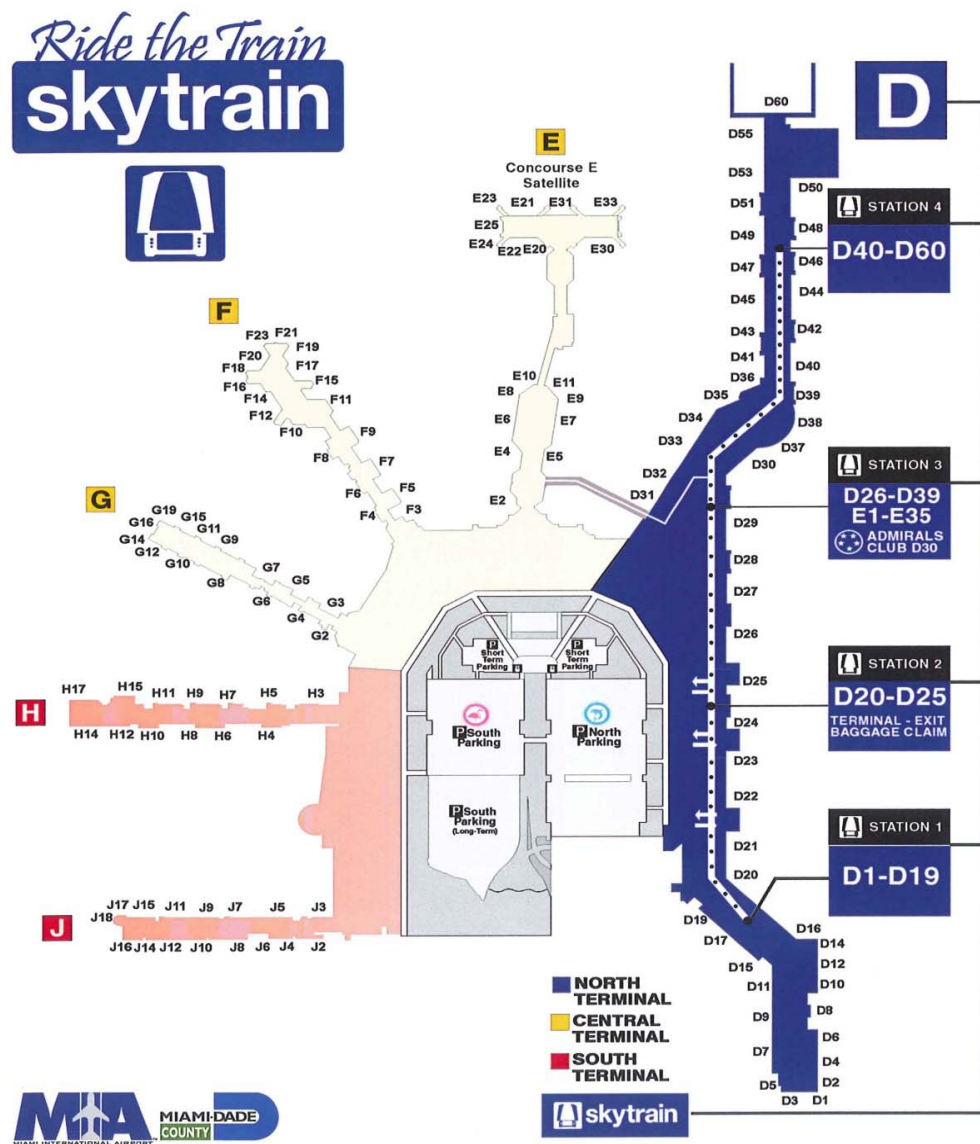


Figure 3. Skytrain Map

The system also includes an off line Maintenance & Storage Facility (M&SF) which includes 2 light maintenance lanes where daily inspections and light maintenance activities can be accomplished and 2 heavy maintenance lanes which are used for longer term maintenance and vehicle overhauls as shown in Photo 9 below.



Photo 9. Train on Light Maintenance Lanes in M&SF

Photo courtesy of Lea+Elliott, Inc.

Challenges Due to Construction Delays

The NTD construction was broken up into several construction packages as described above and defined in Table 1 which were all spanned by the new rooftop APM system. Many challenges were encountered when coordinating the APM System interface requirements with each of these individual contracts and multiple A/E's and contractors. The skytrain was a stand alone contract that was required to interface with each of the other facilities contracts. The system supplier for the new Skytrain was Sumitomo Corporation of America (SCOA) together with Mitsubishi Heavy Industries of America (MHIA) providing their Crystal Mover technology. The APM System contract was awarded in November 1999 with an original completion date scheduled for June 2004. The APM project suffered significant impacts related to construction delays and was completed in September 2010 more than 6 years later than originally planned. This paper is not intended to focus on the causes for such delays and extended project duration but rather will focus on the impacts on the APM system project and strategies used to mitigate these impacts.

Storage and Maintenance of Purchased Equipment

Although the North Terminal Development Program was suffering from construction delays early on in the program, it could not have envisioned what the extent of the impacts on the construction schedule would be. As such, in an effort to keep projects moving forward, the APM Contractor was directed to proceed with the design and manufacturing of long lead items such as the APM Cars, train control equipment,

communications equipment and power distribution equipment. As time went on and fixed facility construction continued to fall behind schedule the suppliers worked on efforts to slow down manufacturing of equipment but there were limitations of their ability to slow manufacturing. At this time MHIA was gearing up their facility in Japan for manufacturing of new cars for other upcoming projects they were involved with and as such the window of opportunity to slow up the manufacturing was getting smaller. Other suppliers were facing similar constraints in their manufacturing facilities and as a result, power distribution equipment was completed and delivered to the airport site in 2003. The last of the 20 APM cars was completed and tested in Japan in May 2005. Other major equipment such as train control and communications were also completed and Factory tested in early to mid 2005.

At this time in 2005 the site was not yet available to allow the APM contractor to install this equipment. The County was faced with making some very difficult decisions. The County had to decide whether the trains should be shipped to Miami and stored locally or would it be better to leave them in Japan in the care of the vehicle manufacturer? Many things were considered as part of this difficult decision. First, the contract would only permit payment to be made for the completed APM cars upon delivery of the cars in Miami. Secondly, if the cars were delivered to Miami where could they be stored and maintained? The storage facility would need to be equipped with 750 Vdc traction power in order to power the trains and keep them in good operating condition. The facility would need to be large enough to accommodate 20 APM cars as well as guideway tracks to store them on and include enough track to allow the cars to be moved around to avoid such things as bearing flat spots and to exercise and properly lubricate and maintain moving parts and electrical systems on board the train. Space on airport property was very limited and would come at a significant premium.

The County and its APM consultant, Lea+Elliott, worked closely with the MHIA to develop a plan to construct a storage area and guideway tracks just adjacent to the MHI manufacturing facility in Mihara, Japan. This plan made most sense as the 750 Vdc traction power was readily available and manpower could be made available with employees of the MHI manufacturing facilities and engineers in Mihara to properly care for the APM cars. This would also save on travel costs of vehicle maintenance technicians and engineers which would be required to travel to Miami to care for the APM cars if they were stored in Miami. The plan included the construction of storage tracks and a mini test track that would be used to move the trains and exercise moving parts of the trains. The storage tracks constructed at MHI's facilities in Japan are shown in photo 10. This facility was used for this purpose successfully from October 2005 through March 2008. In March 2008 the facilities in Miami were able to accept the APM cars on the new guideway. The Maintenance & Storage Facility was also available for limited use. As such the trains were all packaged and shipped from Mihara, Japan to Miami and placed on the new APM guideway at Miami International Airport in June 2008.

The train control equipment was also manufactured and tested in Japan by Kyosan. This equipment was completed and ready for shipment in May 2005. Kyosan recommended that their equipment be stored in air conditioned space and also that the equipment be powered up and maintained rather than just left in storage. As such, space was allocated inside the M&SF in the Central Control Electrical Equipment room. All of the train control equipment was temporarily stored there in this manner as recommended by the train control supplier until such time that the Station Electrical Equipment Rooms (SEERs) were available for final installation of the equipment. The Central Control Equipment Room (CCER) was of sufficient size to accommodate all of the train control equipment including the equipment that was to ultimately be installed in the SEERs at each APM station. The equipment layout in the CCER was such that the equipment that would remain permanently in this room was placed in its final location. The other train control equipment that would be required to relocate to the SEERs were staged strategically so that as each room became available they could be readily removed without disturbing the other equipment that needed to remain.



Photo 10. Temporary Storage Tracks in Mihara, Japan

Photo courtesy of Lea+Elliott, Inc.

All other long lead item equipment such as Power Distribution equipment, station automatic doors, UPS equipment and batteries were all stored in an off-site warehouse in an air conditioned space. This equipment remained in the warehouse also until the facilities were available for installation.

Addressing Loss of Warranty

Since much of the long lead equipment mentioned above was manufactured, tested and delivered between 2003 and 2006 and the forecasted Substantial Completion

Date for the project was now September 2010 many of the equipment manufacturers were not willing to provide warranty's for this extended time period. This was a major concern for the County and something had to be done to limit the County's risk. Lea+Elliott worked closely with the APM contractor and the County to determine exactly what items would not be covered by warranty. Once these items were defined the next step was to evaluate the risk of not having the standard 1 year warranty in place after the projects Substantial Completion as required by Contract.

Non-Warranty Items

The non-warranty items included the following major equipment:

1. APM Cars,
2. Train Control Equipment
3. Power Distribution Equipment
4. Automatic Station Platform Doors

The major risk items were determined to be the APM Cars, Train Control Equipment and the Automatic Station Platform Doors. The major components of the Power Distribution Equipment were Transformer/Rectifiers, AC Switchgear and DC Switchgear. This equipment was not considered as a high risk item for the County simply due to its inherent reliability and the fact that they were stored in a proper manner and were not subject to significant deterioration over the extended time period. The APM Contractor is currently negotiating extended warranty's with the Power Distribution System Supplier.

APM Cars

The APM cars were a major concern for the County. In an effort to mitigate risks associated with the loss of warranty the County and the APM Consultant worked closely with the APM Car manufacturer to develop an inspection and consumable replacement plan for each of the 20 APM cars. The plan focused on inspections of potential wearing and/or deteriorating parts on the APM cars. If the inspections determined that parts were excessively deteriorated and needed replacement they were. If they required additional lubrication or other corrective action this was then performed. The County included this as part of a Change Order that was executed with the APM Contractor. As a result the APM cars have been operating in service for over 4 months at the time of the writing of this paper with excellent success and with an overall availability of approximately 99.5%.

Train Control Equipment

Similarly, the train control equipment was of major concern to the County. Again the County, the APM Consultant and the APM Contractor worked closely with the train control provider to identify an inspection/replacement plan for the train control equipment. Since most of this equipment electronics and control boards the main focus was to check proper functionality of the cards, power supplies and relays. Items that were determined to not function in accordance with the manufacturer's requirement would be either replaced or repaired accordingly. The County also included this as part of the APM Contractor's Change Order to mitigate potential non-warranty risks to the County.

Automatic Station Platform Doors

Lastly, the Automatic Station Platform Doors, which are notoriously a maintenance and reliability issue for most systems, were addressed in a similar manner. The manufacturer of the equipment came to the site and performed thorough inspections of the doors and operators/controller and developed a list of corrective actions and repairs or component replacements. This list was included in the APM Contractors change order to mitigate potential non-warranty risks to the County. The door manufacturer also provided a full warranty and guarantee on the doors in accordance with the original contract requirements after the work was completed.

Summary

The Miami International Airport (MIA) had to overcome many obstacles and challenges in order to successfully complete the North Terminal Development Program. Each challenge was unique and in many cases has never been encountered before on any other project. MIA along with its consultants, A/E's and contractors faced each of these challenges together and were able to successfully overcome each and every challenge with great success.

The North Terminal Program inspired the vision for Miami International Airport building for the future; making Miami an even greater center of commerce and tourism and the economic engine of the County, the State and the Region.