MP 00W0000164

MITRE PRODUCT

URET Daily - Use Metrics and Benefits Analysis - Progress Report

August 2000

Marilyn Walker
Paul Long
Niamh Lowry

Sponsor:	Federal Aviation Administration	**Contract No.:**	DTFA01-C-93-00001
Dept. No.:	F042	**Project No.:**	02001301-M1

Approved for public release; distribution unlimited.

MITRE
Center for Advanced Aviation System Development
McLean, Virginia

Abstract

The Free Flight Phase 1 (FFP1) Program is designed to provide benefits to National Airspace System (NAS) users through the limited deployment of the core capabilities of several decision support systems by the year 2002. One component, the User Request Evaluation Tool (URET) will be implemented at seven Air Route Traffic Control Centers (ARTCCs). Currently, a URET daily-use (DU) system is operational at two centers: Indianapolis (ZID) and Memphis (ZME). Both facilities are operating 22 hours a day 7 days a week.

Since February 1999, The MITRE Corporation's Center for Advanced Aviation System Development (CAASD) has been systematically examining the use of URET at ZID and ZME on a monthly basis. CAASD is also assisting the sites in planning benefit-producing evaluations. CAASD is collecting URET data and analyzing the tool-generated metrics to determine how the URET system is being used and what additional benefit-producing activities can be performed at the centers. This data analysis has been augmented with on-site observations of URET operations at both sites.

This report documents the analysis results to date. This activity will lead to the establishment of a process that will be used at the other five FFP1 URET sites to integrate URET into their operations more quickly, thus providing early user benefits.

KEYWORDS: Altitude restrictions, Benefits, FFP1, Metrics, URET

Acknowledgments

The authors wish to acknowledge the helpful cooperation of the operational personnel at the Indianapolis and Memphis Air Route Traffic Control Centers (ARTCCs) in support of the visits and the evaluation work required for this report. The authors would also like to thank Beverly Cottom and Angela Signore for their careful preparation of the document for publication.

Table of Contents

List of Figures

List of Tables

Section 1

Background

The Free Flight Phase 1 (FFP1) Program is designed to provide benefits to National Airspace System (NAS) users through the limited deployment of the core capabilities of several decision support systems by the year 2002. One component, the User Request Evaluation Tool (URET), will be implemented at seven Air Route Traffic Control Centers (ARTCCs) (see Figure 1-1). Currently, a URET daily-use (DU) system is operational at two centers: Indianapolis (ZID) and Memphis (ZME).

The URET DU system serves as a means of understanding procedural and training issues that need to be addressed for the success of URET in FFP1. It also provides an opportunity to evaluate prospective benefits to users and to achieve user benefits as early as possible.

NAS users are supportive of the FFP1 Program in the expectation that it will provide them with cost savings. The airlines participate in the FFP1 Program through External Stakeholders meetings. At the November 1999 meeting, the airline representatives reaffirmed their support for the development of URET and the use of the URET DU system at ZID and ZME. However, they were concerned that benefits are not being achieved faster. They expressed support for the initiative at ZID and ZME to provide user benefits through the lifting of altitude restrictions; but they want results affecting more aircraft faster.

URET has been used on a daily basis at ZID and ZME since 1997. Approximately 800 operational personnel have been trained on the operation of the tool. Both facilities are operating 22 hours a day 7 days a week. The use of the tool at each facility has increased dramatically since 1998. Controllers have come to accept the tool as a new way of doing business and have largely integrated it into their strategic planning. Since February 1999, the MITRE Corporation's Center for Advanced Aviation System Development (CAASD) has been systematically examining the use of URET at ZID and ZME on a monthly basis. Important excerpts of these reports are reviewed each month at the FFP1 monthly program reviews.

CAASD is also assisting the sites in planning benefit-producing evaluations. CAASD is collecting URET data and analyzing the tool-generated metrics to determine how the URET system is being used and what additional benefit-producing activities can be performed at the centers. This data analysis has been augmented with on-site observations of URET operations at both sites. This activity will provide the fundamental framework to establish a process for the other five FFP1 URET sites. The goal is to integrate URET quickly into daily operations and provide early user benefits.

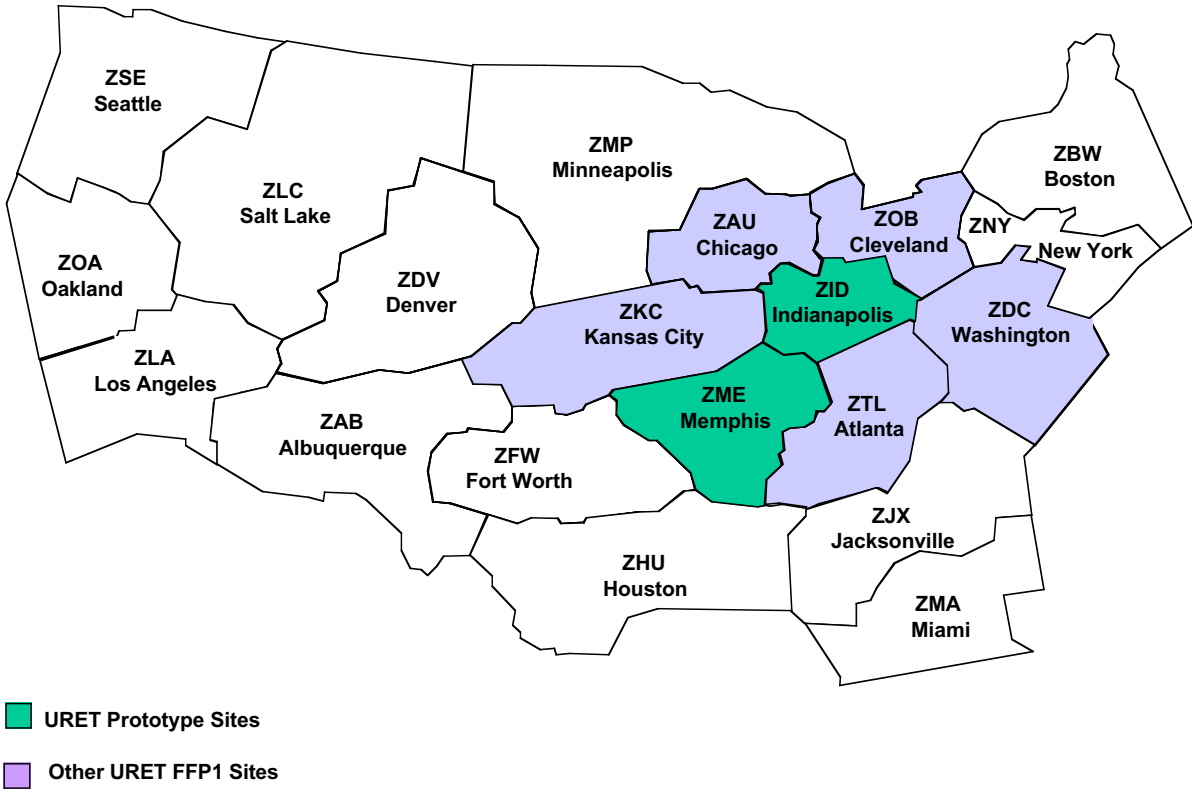

Figure 1-1. URET FFP1 Implementation Sites

The potential benefits of URET during FFP1 are summarized IN [Celio et al, 2000b]. This document is the first in a series of reports that will document the ongoing analysis work. Future reports will be issued with updated analysis results.

1.1 URET Functionality

The key capabilities of URET for FFP1 are:

- Trajectory modeling
- Aircraft and airspace conflict detection
- Trial Planning to support conflict resolution of user or controller requests
- Electronic flight data capability.

URET processes real-time flight plan and track data from the Host computer system. These data are combined with site adaptation, aircraft performance characteristics, and winds and temperatures from the National Weather Service in order to build four-dimensional flight

profiles, or trajectories, for all flights within or inbound to the facility. URET also provides a "reconformance" function that adapts each trajectory to the observed speed, climb rate, and descent rate of the modeled flight. For each flight, incoming track data are continually monitored and compared to the trajectory in order to keep it within acceptable tolerances. Like the Host computer system, each URET is center based. However, neighboring URET systems will exchange flight data, position and reconformance data, and status information in order to model accurate trajectories for all flights up to 20 minutes in the future.

URET maintains "current plan" trajectories, i.e., those that represent the current set of flight plans in the system, and uses them to continuously check for aircraft and airspace conflicts. When a conflict is detected, URET determines which sector to notify and displays an alert to that sector up to 20 minutes prior to the start of that conflict. Sector notification is based on the sector in which the point-of-violation (POV) is predicted to take place. Trial planning allows a controller to check a desired flight plan amendment for potential conflicts before a clearance is issued. The controller can then send the Trial Plan to the Host via URET as a flight plan amendment. Coordination of Trial Plans between sectors, which might include those of neighboring centers, may be achieved non-verbally using Automated Coordination capabilities.

These capabilities are packaged within a Computer Human Interface (CHI) that includes text and graphic information. The text-based Aircraft List and Plans Display manage the presentation of current plans, trial plans, and conflict probe results for each sector. The Graphic Plan Display (GPD) provides a graphical capability to view aircraft routes and altitudes, predicted conflicts, and trial plan results. In addition, the point-and-click interface enables quick entry and evaluation of trial plan route, altitude, or speed changes and sending the flight plan amendment to the Host. For more detailed information about URET capabilities, benefits and operational concept please refer to [Celio et al, 2000a] [Celio et al, 2000b] on the URET web-site, www.caasd.org/Research/URET. Several documents and summaries are available for downloading.

1.2 Document Scope

Section 2 describes the DU metrics that are being collected and analyzed each month. These metrics include the usage of URET through the month of April 2000 and trends in selected metrics from the prior months. This metrics collection and analysis will continue until the FFP1 URET system is deployed.

Section 3 is an operational analysis stemming from the collected metrics as well as observations at ZID and ZME. Some preliminary conclusions are provided.

Section 4 discusses the analyses that have been accomplished at ZID and ZME in relaxing static altitude restrictions. This area seems to have the most potential for achieving near-term benefits from the use of URET. Evaluations have been conducted to determine if the strategic planning capabilities of URET will allow certain static restrictions to be relaxed during some portions of the day.

Section 5 is an analysis of the economic benefits to airlines in removing static altitude restrictions. Data obtained from airlines is used to estimate the fuel penalty for flying at less than fuel-efficient flight levels.

Section 6 describes the activities continuing throughout the year, both in the collection and analysis of DU metrics and the accrual and analysis of benefits to NAS users through the lifting of altitude restrictions.

Section 2

URET DU Metrics

URET has been in daily use at ZID and ZME since the fall of 1997. In order to determine what benefits URET is providing, it is important to examine how URET is being used. Metrics on the use of various URET capabilities are collected and updated on a monthly basis. A set of metrics is produced based on the daily files generated by URET at ZID and ZME. This set of metrics has grown since February 1999 when such data were first examined on a systematic basis.

As of April 2000, the following metrics have been shown to be most useful in determining the use of URET at both ZID and ZME. The April 2000 report is used for the examples shown throughout this section. In general, both ZID and ZME metrics have similar characteristics so only one of the graphs is included in this section. When the metrics differ substantially between ARTCCs, both graphs are included.

- URET Utilization
- URET Trial Plans (TPs) and URET–initiated Amendments (AMs)
  - Six month trend of TPs and AMs
  - Center Summary of TPs and AMs by the month and by time of day
  - Alert Notification "Color" of TPs when an AM is initiated
- URET Alert Counts by Alert Notification Color
  - Daily Counts of Unique Conflicts
  - Monthly Trends
- Direct Routing Amendments (Counts of Total Directs and URET Directs)
- Distance Savings for Lateral Amendments

2.1 URET Utilization

Over time, URET has grown from a single workstation to full center operations at both sites. The operational hours have grown from eight hours a day five days a week to 22 hours daily, seven days a week. Figure 2-1 illustrates the usage trend over the past year at both ZID and ZME.

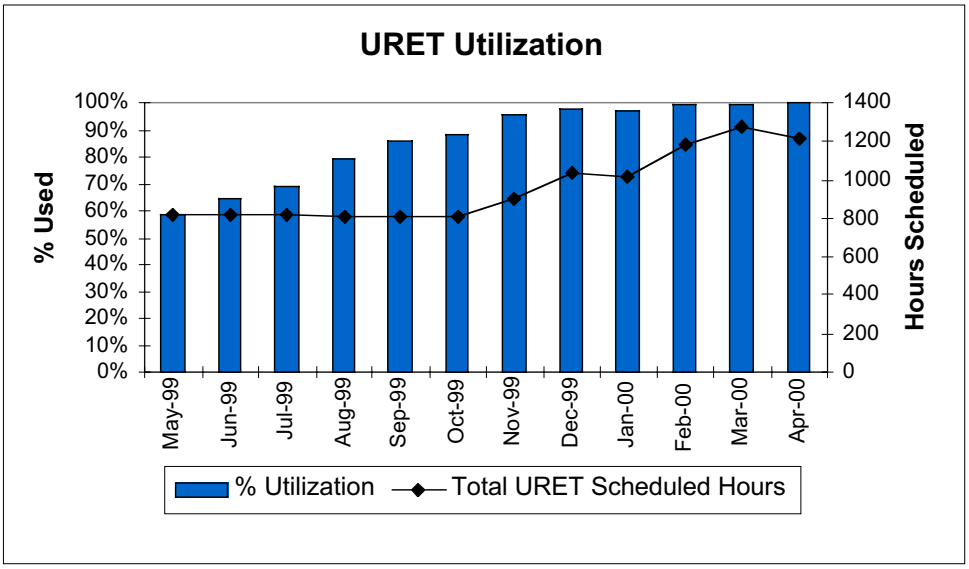

Figure 2-1. URET Utilization ZID and ZME

2.2 URET Trial Plans and Amendments

One of the core URET functions is the ability to do "what-if" analysis via Trial Planning. Since July 1999, the controllers have been able to send amendments built via URET's Trial Planning functionality back to the Host. Prior to this 2-way interface, an amendment would need to be "re-typed" on a Host keyboard in order to input the change into the Host. The 2-way functionality greatly increased the use of URET as a tool for the controller.

A controller has the option to build many types of TPs in URET: altitude changes, direct to downstream fixes, reroutes (e.g., typing in new fixes), graphic reroute (e.g., drawing a route on the screen using the trackball), speed changes, turning off/on known altitude restrictions, and adjusting downstream altitude maneuver start points. However, only the first four types of TPs (the most common) are eligible to be sent to the Host.

Of the TPs built in a day, the majority of them are sent to the Host as amendments. The metrics include the number of TPs built, the number sent as AMs, and the breakout of the type of AM (direct to downstream fix, other laterals, or altitudes). Some AMs are rejected by the Host for various reasons; these cases are also reported.

2.2.1 Six Month Trend of Trial Plans and Amendments

These metrics show the trend over time of URET TPs and AMs. The total number for a month of each category is divided by the days in the month to produce a daily average of that category for the month. Figure 2-2 shows continual growth in URET usage. Although ZID

is used in this example, a similar trend for ZME exists. While ZME shows continued growth in April, the smaller value in April for ZID may indicate that ZID is reaching the TP plateau for steady-state use. Additional data will indicate if this explanation is valid.

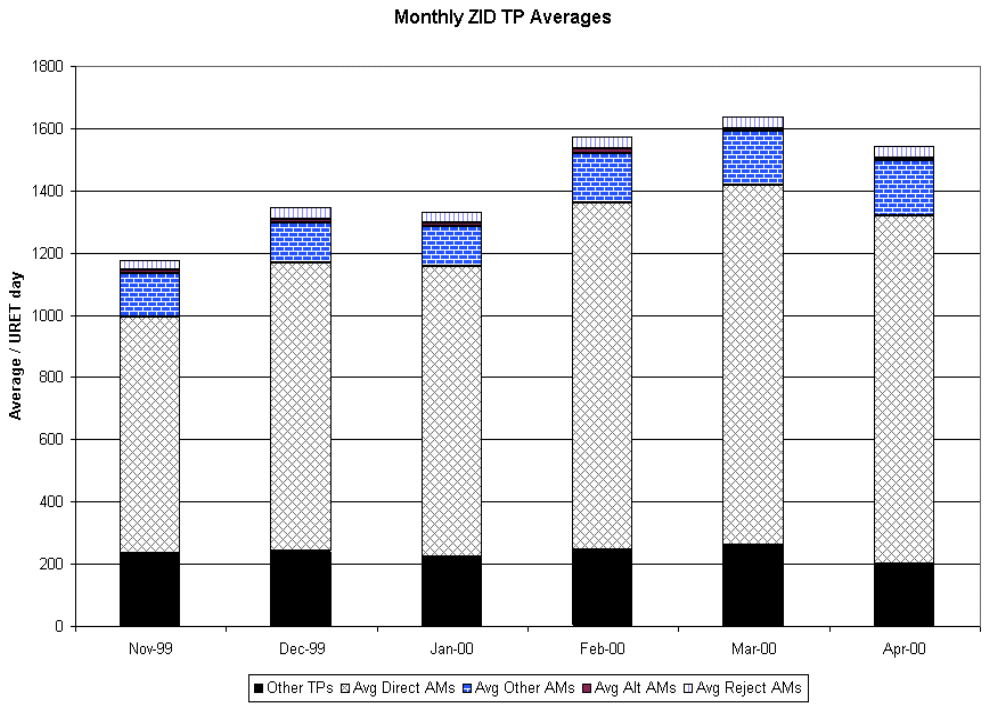

Figure 2-2. Monthly ZID Trial Plan Averages

2.2.2 Center Summary of Trial Plans and Amendments

Figure 2-3 illustrates URET usage is almost in direct correlation with traffic volume. The metric is calculated by summing all TPs, AMs, and tracked aircraft during a 2-hour interval every day of the month if URET is running. That sum is divided by the number of days URET was available during that time-range. For the month of April in ZID, between 1400Z and 1600Z, on average 177 TPs were generated, 149 of which were entered and accepted by the Host as flight plan amendments. During that same 2-hour interval, an average of 956 flights were being tracked in ZID. The equivalent numbers for ZME are 103 TPs, 76 AMs, and 859 average tracked aircraft.

This metric quantitatively dispels a widely distributed myth about URET that URET usage goes down as traffic volume increases.

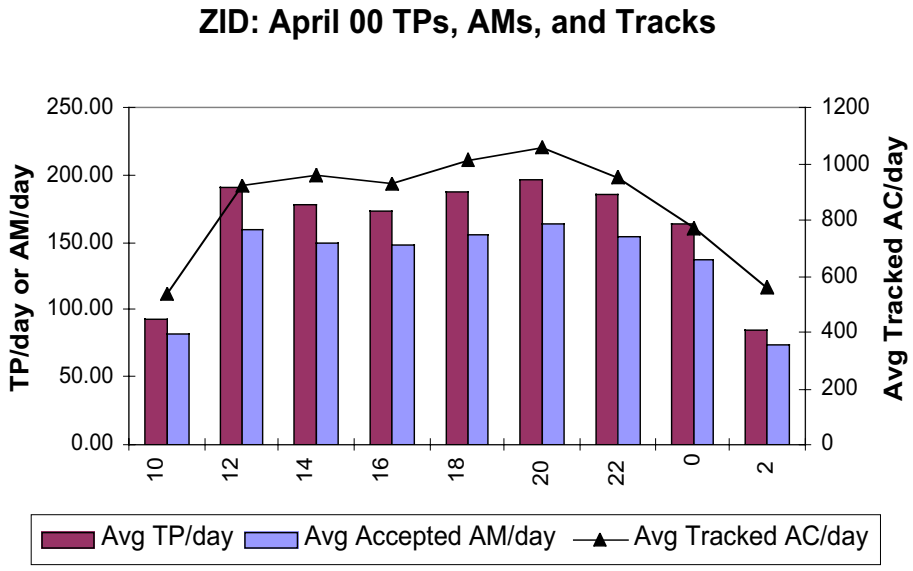

Figure 2-3. Daily Average Counts of Trial Plans, Amendments, and Tracked Aircraft

2.2.3 Alert Notification "Color" of Trial Plans When an Amendment is Initiated

A TP is red when the loss of separation for an aircraft alert is less than a procedural separation defined by a parameter (5 nautical miles); it is yellow when the loss of separation is greater than procedural separation and within the problem detection threshold defined by the parameter; it is green when URET predicts that it is conflict-free; and it is blue when an airspace conflict is predicted. Based on the URET operations concept, it was anticipated that controllers would attempt to build a conflict-free TP (i.e., a green TP). If the first attempt were unsuccessful, additional TPs would be built in order to obtain a green TP. When a green TP was created, that TP would be sent as an amendment to the Host. On occasion, the controller would make a trade-off and send amendments with conflicts.

To verify this operational concept, the alert-notification color of the TP sent as an amendment was analyzed. The total number for a month of each color is divided by the days in the month to produce a daily average for the month. For this metric, ZID and ZME have very different trends. Figure 2-4 shows the ZME results while Figure 2-5 shows the ZID results.

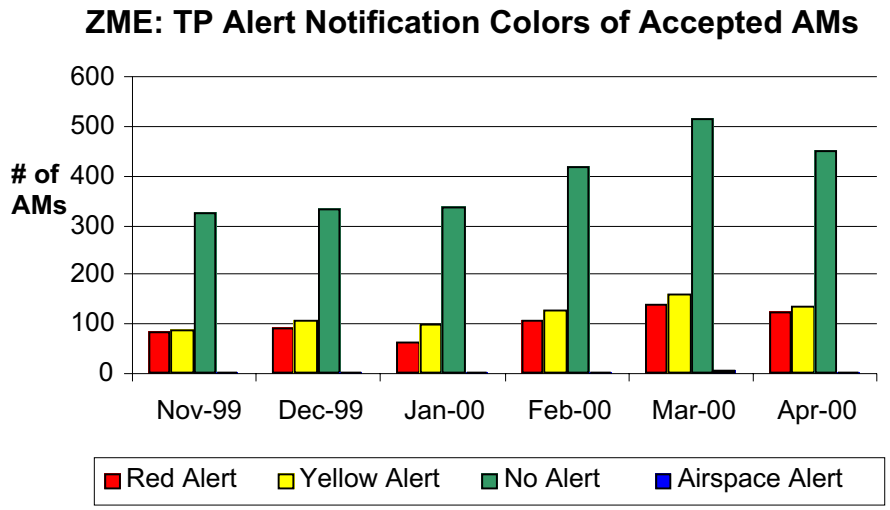

Figure 2-4. ZME: TP Alert Notification Colors for Accepted AMs

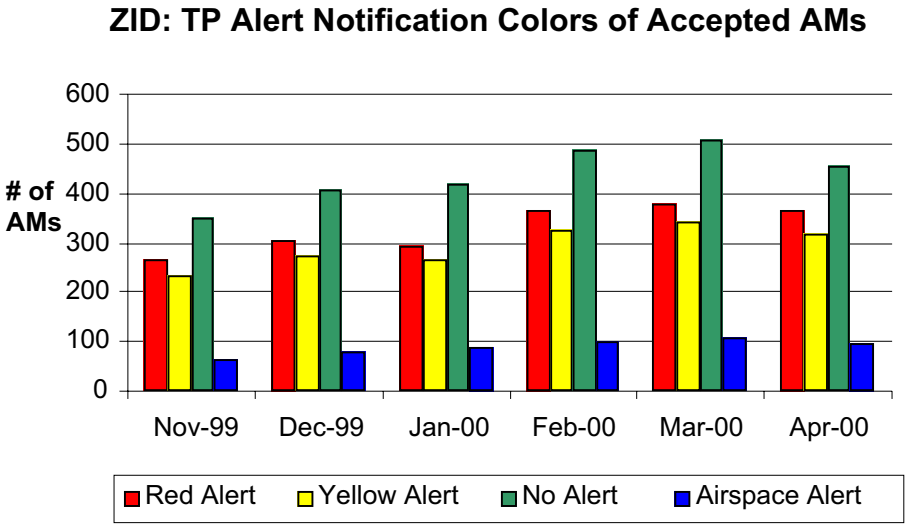

Figure 2-5. ZID: TP Alert Notification Colors for Accepted AMs

ZME's graph closely follows the anticipated ratios of many "green" amendments and few amendments with conflicts. In ZID's case, the red and yellow counts are nearly equivalent to the green counts.

There are many possible reasons for this situation in ZID:

- The number of amendments is higher in ZID than ZME; the contrast may be a function of traffic count.
- This metric is looking at the conflict results for a TP. More alerts are likely to be displayed for a TP than for the Current Plan after the amendment is implemented. The contrast between TP and Current Plan probe output is described below.
  - Alert Notification Rules: when a TP is built, any detected conflicts are displayed to the requesting controller. By contrast, the Current Plan probe only displays alerts to the sector where the loss of separation is predicted to occur.
  - Likelihood of Conflict: The Current Plan probe examines each conflict before notification for likelihood. For example, if the detected conflict is over 15 minutes away and one of the aircraft is frequently reconforming, the likelihood function may suspend notification until the conflict seems more "stable".
  - "Muted" conflicts. The Current Plan trajectory has parts that have not yet been cleared to the aircraft but are anticipated to be flown. An obvious example is the clearance to descend from cruise altitude to land at the airport. The URET trajectory builder selects a point for these maneuvers to begin, but many factors influence the actual maneuver start point. If a conflict is detected on that portion of the trajectory, which is uncleared, the alert notification is considered "muted". Since the entire TP trajectory could be considered "uncleared", this muted distinction from the probe is not made.
- This metric does not identify tradeoffs. If a red alert with a 2-minute warning time is exchanged for a red alert with a 10-minute warning time, the air traffic situation is improved. But this metric is not detailed enough to detect these tradeoffs.
- Using URET, it is frequently easier to input amendments than using the Host equivalent process. Some controllers have explained that they are updating the system via URET with the latest clearance (e.g., radioed by the R controller). The results of the probe are irrelevant in that ATC context.

Further investigation will be required to fully understand the results of this metric. An analysis tool has just been completed that will enable a more detailed analysis using the raw data.

2.3 URET Alert Counts by Alert Notification Color

The conflict probe in URET continuously monitors and updates conflicts. An algorithm based on the time to violation and likelihood of a separation violation is used to determine if an alert is displayed for the conflict. A unique conflict is identified internally by a problem-identifier for conflicts for which the same aircraft pair is involved and for which the time of predicted violation changes minimally. Updates can be caused by amendments or by reconformance based on track data. Such updates can change the alert notification color. For an aircraft conflict, the alert notification colors, in decreasing severity, are red, yellow, muted_red, or muted_yellow. In this metric, the highest severity color of each unique problem is identified.

2.3.1 Daily Counts of Unique Conflicts

For the four alert notification colors, the daily count of each alert color for ZID is displayed in Figure 2-6. The weekends show a reduction in counts due to reduced traffic on Saturdays and Sundays.

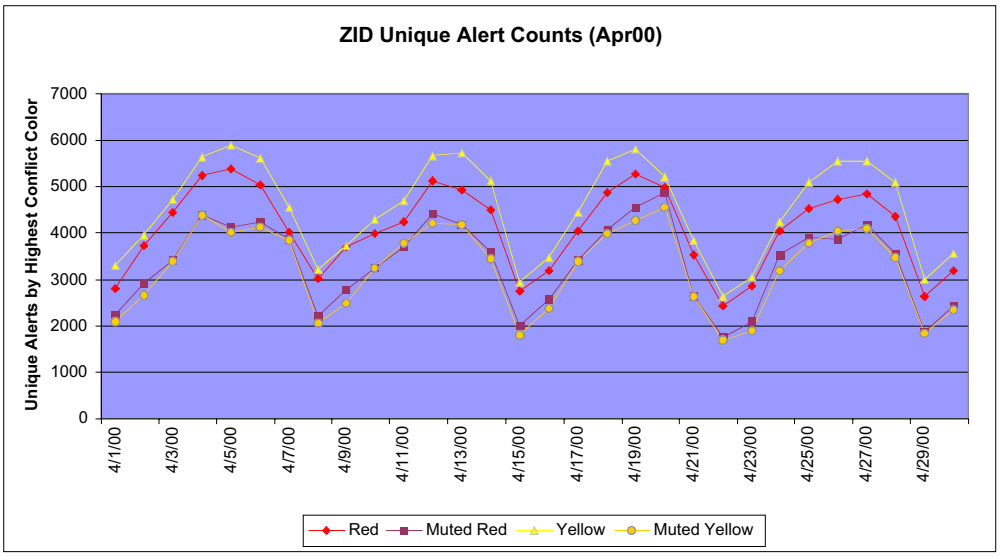

Figure 2-6. Unique Alert Counts

2.3.2 Monthly Trends of Unique Conflicts

For ZID and ZME, the weekday average of the red and yellow alerts for each month is presented in Figure 2-7. ZID consistently has a higher alert notification count than ZME.

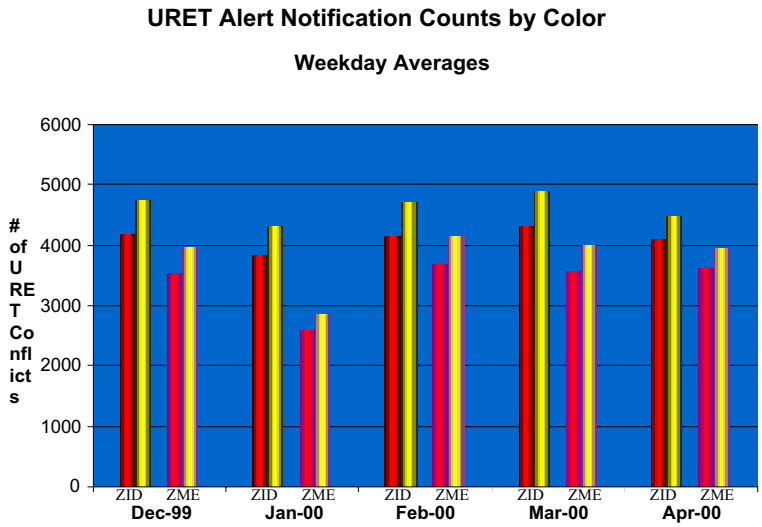

Figure 2-7. Average Daily Alert Counts by Center

2.4 Direct Routing Amendments

When 2-way communications between URET and Host started, many URET controllers said that they were granting more directs. This analysis looks at the number of directs in both the ZID and ZME systems and determines the source of the amendment (Host or URET).

Using the data sent to URET from the Host, any flight plan amendment which caused a shorter trajectory to be built was considered a "direct". The URET AMs that were created as direct TPs are also counted. The counts for ZID are shown in Figure 2-8.

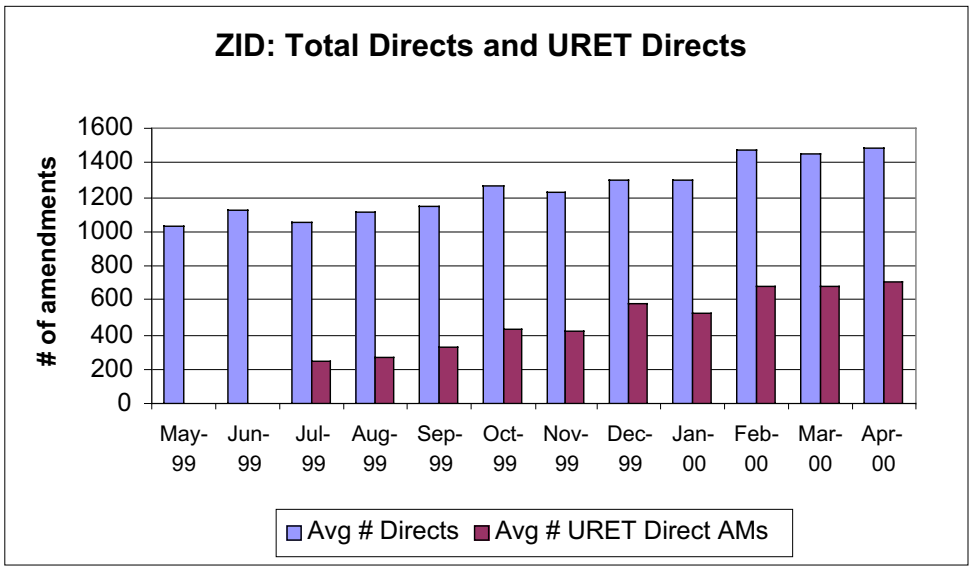

Figure 2-8. Counts of Total Directs and URET Directs

Note that the data were analyzed on a sampling rate of twice per week. More data reporting and analysis are needed before any conclusions can be drawn from this metric.

2.5 Distance Savings for Lateral Amendments

Using the same raw data used for the Direct Routing amendments analysis, this metric looks at all lateral amendments (not just those with a distance reduction). The daily sum of lateral amendments shows an overall reduction (or savings) in the lateral dimension for both ZID and ZME, as depicted in Figure 2-9.

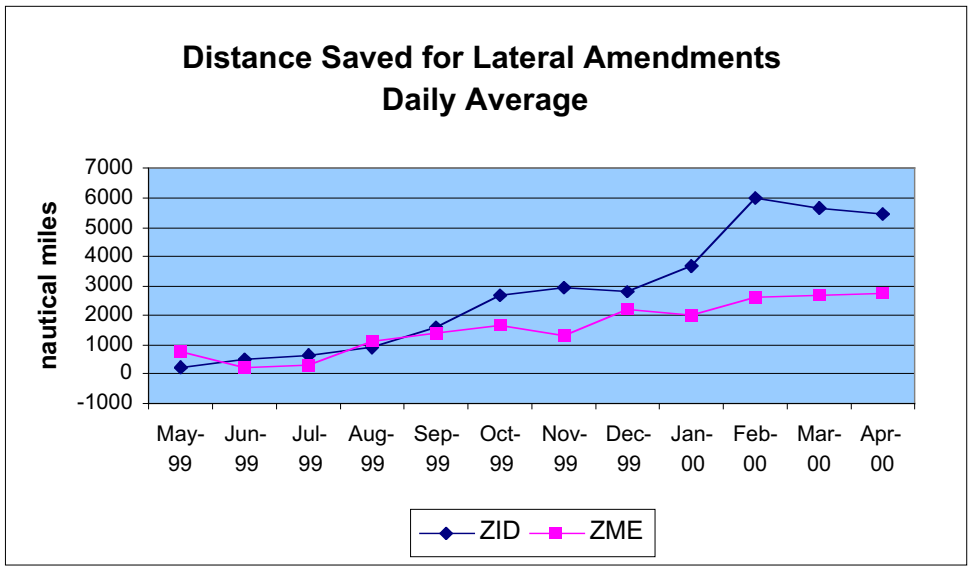

Figure 2-9. Distance Saved for Lateral Amendments

Section 3

URET Operational Analysis

The URET DU system is a decision support system (DSS) to enable D-side controllers to perform their jobs more strategically, reducing controller workload and increasing benefits for NAS users. Since February 2000, the URET DU system has been operational 22 hours a day, 7 days a week at both ZID and ZME.

This section describes the increasing integration of the URET DU system into the operating environment at both ZID and ZME. It describes the use of URET during the ZID transition to DSR (for a description of the DSR transition at ZME, see Walker, Lowry, 2000). Additionally, this paper discusses how the operational personnel are integrating URET into center operations at ZID and ZME; and describes the process that the sites have undertaken to standardize "URET Recommended Operational Practices" for training in effective use of the URET tool.

3.1 URET DU System at ZID

Controllers use URET in all sectors all of the time that it was available, except for sectors where a controller was being trained (see Figure 2-1, URET Utilization). During part of the training, controllers are required to use paper strips.

3.1.1 ZID DSR Transition

Operational personnel at ZID requested the support of URET during the transition to the new DSR control room. They found the URET DU system extremely helpful. The entire ZID Center transitioned to the DSR control room on Saturday, 4 March 2000. The URET DU system was scheduled to become operational in the new control room 24 hours after the transition. However, at the request of operational personnel it was brought up on Saturday morning at the same time that the transition to DSR took place.

The ZID DSR transition plan was scheduled to be in effect for 30 days, starting 4 March 2000, 0700Z. The plan is very specific, placing Miles-in-Trail (MIT) restrictions on arrivals and departures within ZID airspace, imposing restrictions on National Route Program (NRP) filing for some city pairs through ZID airspace, and placing specific restrictions on arrivals into ZID airspace from neighboring facilities. Traffic Management Unit (TMU) personnel evaluated the plan on a daily basis, lifting restrictions early when possible; e.g., TMU personnel lifted restrictions on freighter operations at night, not including Federal Express, after a few days.

The role of the URET DU system in the transition is difficult to isolate. Controllers clearly wanted to have URET available throughout the transition period. They said that

URET reduced their workload, which made it easier for them to contend with the transition to the new DSR system. Although the ZID plan called for the restrictions to be in effect for 30 days, the restrictions were lifted early. They were imposed on 4 March 2000, and lifted after 24 days. TMU personnel consider that the transition was smooth, without major problems.

Anecdotally, controllers said that URET was extremely helpful during the transition to DSR. They said that URET was an integral part of the transition, as evidenced by the request that URET be available a day earlier than planned, at the beginning of the transition. URET helped controllers reach a level of comfort with the new system more rapidly. Controllers indicated that they would have had a harder time adjusting to the new system if they had been required to revert to the use of paper flight strips.

3.1.2 Some Operational Impacts of the URET DU System at ZID

The ZID Procedures and Benefits Team has noted ways that the URET DU system helps controllers to do a better job and to provide benefits to NAS users. They are finding the URET DU system helpful in unanticipated ways and are actively seeking to use its capabilities for workload reduction and NAS user benefits.

With the approach of summer and the advent of the thunderstorm season, the graphic re-route capabilities of URET make it easier for the controller to enter route deviations due to weather. For example, 20 April 2000, was a particularly bad weather day in ZID airspace. On that day, controllers invoked graphic trial planning 66 times. The daily average usage of graphic trial planning at ZID during April was less than 20. Basically, most of the aircraft were playing follow the leader through the weather based on route information provided to the controller by URET. The team also considered that the increased strategic planning was a benefit to users, providing the pilot with better information earlier.

The ZID Procedures and Benefits Team is also working actively to expand the use of URET within the center. The Team is working to change procedures so that URET DU can be more effective. The two specific efforts described below have not yet been fully authorized; they are provided as illustrations of the kinds of operational changes that the site personnel are seeking in order to make more efficient use of the tool.

- The Team is recommending that the URET DU system be used by controllers during radar training. Currently, at ZME, trainees are required to use paper flight strips at the first two sectors. Order ZME AT6100.2C, effective 6 March 2000, states that "the utilization of URET with OJT on the radar associate position (D-Side) is allowable provided the radar associate controller trainee has successfully completed training on the first two radar associate positions." The ZID procedures and Benefits Team is recommending that URET be used during all training at the radar associate position. The ZID ARTCC has requested that ATP110 grant a waiver of the

requirement for marking of paper strips during training. The issue has not yet been resolved.

- The Procedures and Benefits team is coordinating the training of the TMU specialists on maintenance of the Special Use Airspace (SUA) menu. Currently, the responsible controller invokes a SUA menu that provides the capability to change an SUA area from restricted to non-restricted and vice versa. The TMU specialists have the most accurate data on the status of the SUA areas, and therefore they could maintain the currency of this data for URET. A change in the Standard Operating Procedures is required for this modification to become effective. It is anticipated that the change will be authorized in the June timeframe. The TMU will begin controlling this data from a central location when authorization is granted.

3.2 URET DU System at ZME

According to the Memphis ARTCC URET Activities Weekly Reports, "Frequent daily observations of usage in the control room reveal that, of the 37 sectors to which URET is available, all 37 are continuously utilizing URET during the scheduled hours. When specific sectors are providing traditional (flight progress strip) training, URET is not used at those sectors."

The ZME ARTCC transitioned to the new DSR system in a new control room during November 1999 (see Walker, Lowry, 2000). The transition to the DSR system went very smoothly, with the fewest DSR-related delays of any of the ARTCCs that had transitioned to DSR prior to Memphis.

3.2.1 ZME DSR Transition

ZME transitioned to the Display System Replacement (DSR) system in a new control room during November 1999. ZME requested that the URET prototype be available 24 hours a day, 7 days a week, rather than the normal 15 hours during the transition. The transition took place between 6 November and 20 November.

During the transition, traffic management imposed miles-in-trail (MIT) and routing restrictions on arrivals for aircraft entering Memphis airspace. All restrictions were imposed only at or above FL240. No restriction was greater than 15 MIT.

One National Route Program (NRP) routing was suspended for traffic out of the Houston Inter-continental terminal area for aircraft that had a preferred routing through Houston/Atlanta. NRP routes from Houston to Atlanta go through ZME airspace. During the first days of the transition, ZME suspended the NRP route. With NRP suspended, the aircraft went from Houston to Atlanta airspace without crossing ZME airspace. That was the only NRP restriction imposed.

Some restrictions were removed before the transition was completed on Day 15.

- On Day 3:
  - Route restrictions for St. Louis arrivals were cancelled.
- On Day 8:
  - The Houston terminal NRP restriction was cancelled.
  - The MIT restrictions on Dallas-Ft. Worth arrivals were dropped to 5 MIT per route.
  - All DSR imposed routing restrictions to Memphis, to structure traffic over transition points, were removed and all published arrival transitions to Memphis were resumed.
- On Day 10:
  - Memphis arrival restrictions were reduced from 15 to 10 MIT.
- On Day 15:
  - All DSR restrictions were cancelled. The Center returned to normal operations.

The transition was remarkably successful with minimal impact. The weather was good throughout the transition period, which helped.

The role of the URET DU system in the transition is difficult to isolate. Traffic management personnel indicated that they did not take the availability of URET into account in the imposition of DSR-related restrictions during the transition. Controllers clearly wanted to have URET available throughout the transition period. They said that URET reduced their workload, which made it easier for them to contend with the transition to the new DSR system.

During the transition, Memphis sectors were staffed with two people, an R- and D-side controller. Under normal circumstances, sectors at ZME are staffed by a single controller. According to controllers, the combination of the increased availability of URET resulting in reduced workload and the two-person sectors helped them through the transition to DSR. The transition took 14 days, with only 7 DSR-related delays, the fewest DSR-related delays of any of the centers that had previously undergone the DSR transition. Thirteen ARTCCs transitioned to DSR prior to Memphis.

3.2.2 Some Operational Impacts of the URET DU System at ZME

As indicated in recent Memphis ARTCC URET Activities Weekly Reports, operational personnel consider URET an important asset to their daily activities. When traffic or weather conditions increase controller workload, controllers turn to URET to help manage the situation. Some examples follow:

- On Sunday, 26 March 2000, URET was scheduled to be brought down at 2030 Central Standard Time in order for MITRE/CAASD to install a new operating system. Due to inclement weather conditions in the area, air traffic requested that the system remain up until the regular shutdown time of 2230. MITRE/CAASD installed the new operating system over a twelve-hour period and the system was made available on schedule 27 March 2000.
- On Sunday, 23 April 2000, as requested by air traffic, URET was made available to operations for an additional one and a half-hours after the scheduled shutdown time because of unexpected traffic congestion.

3.3 URET Recommended Operational Practices

The FFP1 Program Office, MITRE/CAASD, and the ZID and ZME operational personnel are working together to develop a set of "operating recommendations" or "best practices" in the use of URET. The goal is to provide a set of recommended practices that will maximize benefits and increase the operational utility of the DU system. As much as practicable, the best practices are to be incorporated into DU operations. In addition, they will support training requirements for the future deployment of the FFP1 URET system. The DU training program, as it currently exists, does not include any recommendations about how to best use the tool in the context of normal sector operations. It focuses on functionality.

Working with ZID and ZME controllers, CAASD developed a set of DRAFT "best practices" for evaluation by controllers at ZME. On Monday, 17 April 2000, representatives from MITRE/CAASD briefed sixteen volunteer controllers at ZME, representing all five areas, on the proposed recommended practices and asked controllers to "try out" the practices on the control room floor over a 30-day period. Practices to be evaluated include: 1) sector set-up, 2) flight data management, and 3) conflict probe capabilities (current plan alerts and trial planning). At the end of the trial period, on 22 May 2000, CAASD representatives conducted a debriefing. Based on evaluation feedback from the sites, the practices will then be refined.

The recommended practices are not intended to be new procedures; they are suggestions in how to best use URET capabilities. The DU sites will incorporate the suggestions in their training programs as appropriate. Formal site documentation and ownership of recommendations for effective use of URET is a significant step toward the integration of

URET into sector operations. New sites will tailor the suggestions to fit their unique operations. The suggestions act as a starting place for the new sites. They do not specifically focus on increasing NAS user benefits. However, when exercised appropriately for longer-range planning, the strategic capabilities of URET give controllers the capability to provide more benefits to NAS users.

Section 4

Ongoing URET Benefits Work at ZID and ZME

ZID and ZME are continuing to use the URET DU system to provide benefits to NAS users. The main thrust of the activity so far has been in the area of relaxing static altitude restrictions. The January 2000 report (see Walker, Lowry, 2000) documented activity in this area from May through December 1999. Since then, the pace and scope of the activities to evaluate and lift static altitude restrictions have increased.

The methodology identified in the previous report for removal of restrictions has three major aspects: data analysis, operational evaluations, and airline participation. The data analysis work continues. It consists of using internal CAASD tools to help identify candidates for relaxation before a restriction is lifted, and determining the NAS-user benefit from the lifting of the restriction. As described in the next section, operational evaluations at ZID and ZME are continuing and expanding. Airline involvement and participation continues to increase and become more directed and effective.

The following section describes the work of the Procedures and Benefits Teams at ZID and ZME in the lifting of restrictions and airline involvement and participation in the Teams.

4.1 Restriction Relaxation Activities of the Procedures and Benefits Teams

Procedures and Benefits Teams were formed at the two sites in the autumn and winter of 1999 to review operations and determine how URET can help in strategic planning. The teams are reviewing static altitude restrictions to identify candidate restrictions that can be relaxed.

The impetus for the establishment of the Teams was an inter-facility evaluation of restriction relaxation between ZID and ZME that took place in May 1999. Specific restrictions for arrivals into Nashville (BNA) from ZID airspace and into Standiford (SDF) from Memphis airspace were lifted for a two-hour period (for details see Ricker, Walker., 1999). There was general agreement at ZID and ZME that the URET capabilities did support the restriction relaxation and that URET assisted controllers with conflict prediction. Operational personnel acknowledged that URET worked well as an enabler in this short evaluation. They expressed a willingness to review other restrictions and lift them as appropriate. The establishment of the Procedures and Benefits Teams was the result.

The Teams meet once a month. They consist of one controller from each area, a traffic management specialist, and Airspace and Procedures Office specialist, a training specialist and two supervisors. The history of the restriction relaxation evaluations at both ZID and ZME, from the initial evaluation in May 1999 through current activities, is documented in Table 4-1.

Table 4-1. History of Restriction Relaxation ZID and ZME

DATE	ZID or ZME	RESTRICTIONS		IMPACT Potential Savings			
		Restriction	Evaluation Hours or Days	No. of Aircraft	Average NMI per a/c*	Average Gallons per a/c*	Reinstated Yes or No
5/27/99	Both	Nashville (BNA) arrivals; from ZID to ZME sector 41 at FL200 or below	2 hrs.	9	38.7	15	Yes
12/29/99	ZID	Indianapolis (IND) arrivals, from sector 84 to 82 at FL310 or below	3 _ hrs.	4	59	11	Yes
12/30/99	ZID	BNA arrivals; from sector 80 to 81 at FL290 or below	2 hrs.	1	73	20.4	Yes
2/24 - 2/25/00	ZID	IND arrivals from sector 87 to 88 at FL310 or below	4 hrs.	18	57	8	Yes
2/25/00	ZID	Columbus arrivals (A.73) from sector 86 to 85 at FL290 or below	4 hrs.	10	54	7	Yes
3/13 - 4/12/00	ZME	All BNA arrivals 5 Restrictions	30 days**	28	0	0	No
4/1 - 4/14/00	ZID	IND arrivals from sector 18 to 34 at 15,000 feet or below	14 days**	9	9.1	.53***	Yes
4/1 - 4/14/00	ZID	Louisville arrivals from sector 35 to 17 at 15,000 feet or below	14 days**	2	18.5	3.78***	Yes (temporarily)
5/21/00	ZID	Pittsburgh arrivals from sector 83 to 85 at FL290 or below	Permanent	9	88.5	25***	No

* For time of analysis

** 24 hours a day

*** Estimated, based on B737-800

4.1.1 Evaluation of Restriction Relaxation at ZID and ZME

It is apparent from a review of Table 4-1 that the Procedures and Benefits Teams at ZID and ZME have become progressively more aggressive in their willingness to lift restrictions and evaluate the results. During calendar year 1999 three restrictions were temporarily lifted and then reimposed (described in Walker, Lowry, 2000). So far, during calendar year 2000, six sets of restrictions have been evaluated. Of these, arrival restrictions into Nashville in ZME airspace have been permanently lifted. An arrival restriction into Pittsburgh was permanently lifted on 21 May 2000.

In each instance, the URET Procedures and Benefit Team identified restrictions that were candidates for removal. During the evaluation period, the restrictions were turned off in URET and the controllers did not issue the restrictions to the aircraft. However, the Team monitored the process to determine if the situation was acceptable, or if conditions required that the restrictions be reimposed early. At the conclusion of the test period, the effects were assessed to determine whether or not to permanently remove the restrictions.

The next sections describe each of the restriction relaxation activities undertaken by ZID and ZME in this calendar year. Unless otherwise noted, fuel savings specified in the following sections are based upon actual calculations of aircraft types and length of time that aircraft were required to stay at the restricted altitude. Fuel burn data by altitude for 727s, 737s, 757s, 767s, Canadair Regional Jets (RJs) and MD80s was provided by the airlines. Fuel burn calculations for other aircraft types are estimated. See Section 5 for a more complete fuel analysis.

4.1.1.1 ZID: Indianapolis Arrivals – February Evaluation

The first relaxation evaluation this year at ZID took place on February 24 and 25. On February 24 and 25, the restriction that requires Indianapolis Terminal arrivals to cross the sector 87 to 88 boundary at FL310 or below, was relaxed for several hours on each day (See Figure 4-1). The estimate of fuel savings for all 18 flights is 144 gallons.

On February 24, the restriction that requires Columbus Terminal arrivals to cross the sector 86 to 85 boundary at FL290 or below was relaxed for several hours. The estimate of fuel savings for all 10 flights is 70 gallons (see Figure 4-1).

Further estimates were made concerning the possible savings from removing restrictions permanently. Based on the traffic levels estimated from the CAASD analysis and site estimates, these flights represent about 40% of the daily traffic over the two restrictions. The average fuel saved per restriction per day during the evaluation was 80 gallons. This extrapolates to 400 gallons saved per day and 144,000 gallons saved for the entire year if just these two restrictions can be removed.

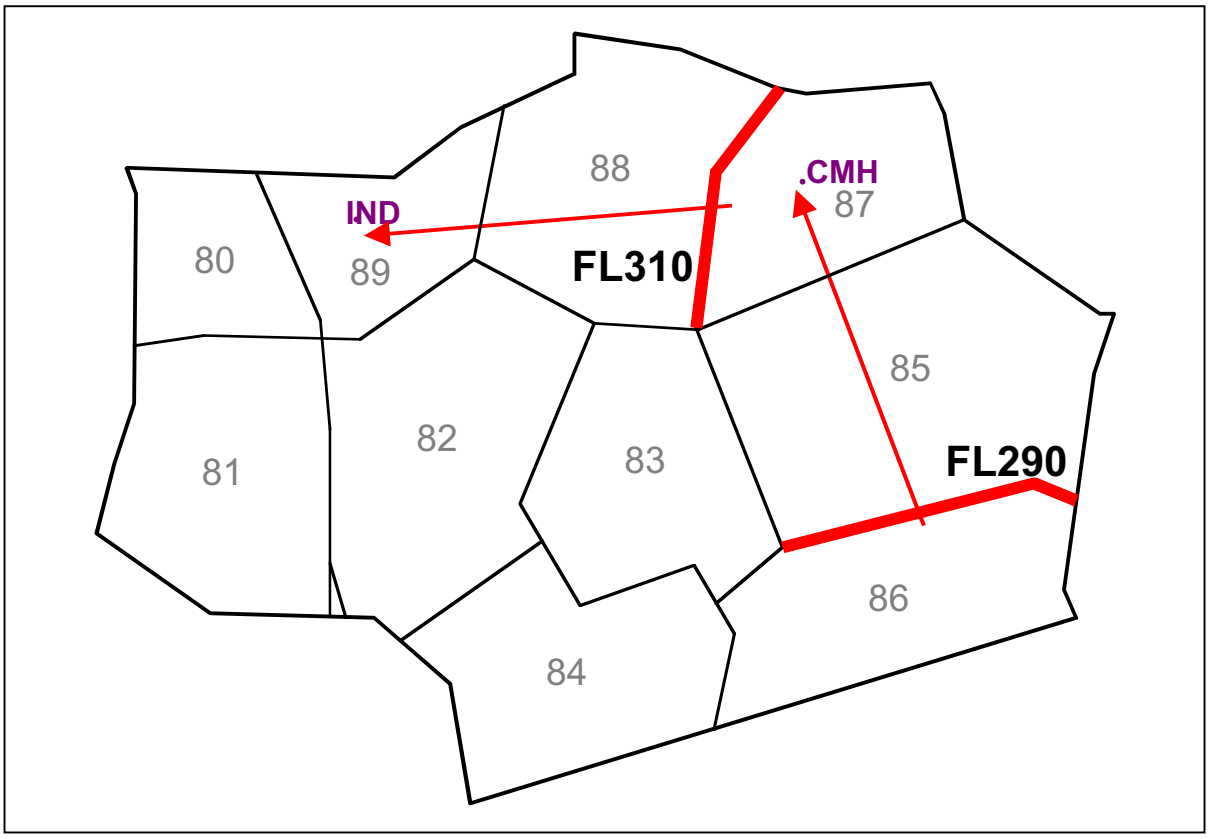

Figure 4-1. Indianapolis Altitude Restriction Evaluation: February 2000

4.1.1.2 ZME: Permanent Removal of Restrictions on Nashville Arrivals

The ZME URET Procedures and Benefit Team identified all the arrival restrictions into Nashville as candidates for removal. There were five crossing restrictions, three from the northwest and two from the south. According to members of the Team, the restrictions were very rarely actually imposed on aircraft.

The restrictions were initially in place to assure that aircraft descended appropriately to meet the approach control restriction into Nashville. The north and west restrictions had been useful about 10 years ago. At that time, aircraft landing at BNA from the west and north were not starting their top-of-descent (TOD) soon enough for a smooth descent to meet the approach control boundary at 11,000 feet (see Figure 4-2). By the time that the aircraft got to sector 42, a low sector, the descent was too steep to meet the crossing restriction smoothly. At that time, some of the airlines welcomed the north and west restrictions as an aid to their pilots to start descending their aircraft earlier. Currently, there are fewer aircraft

into BNA from those airlines. In addition, pilots are starting the TOD in sufficient time for a smooth crossing at the approach control boundary. The crossing restriction from the south into BNA (from sector 13 to 60) was also to assure that aircraft made a smooth transition at the approach control boundary. The south approach is not on a regular flight path. Few aircraft approach the airport via that crossing. CAASD made multiple runs of the Altitude Restriction Tool; in each instance, either no aircraft or only one aircraft crossed that boundary.

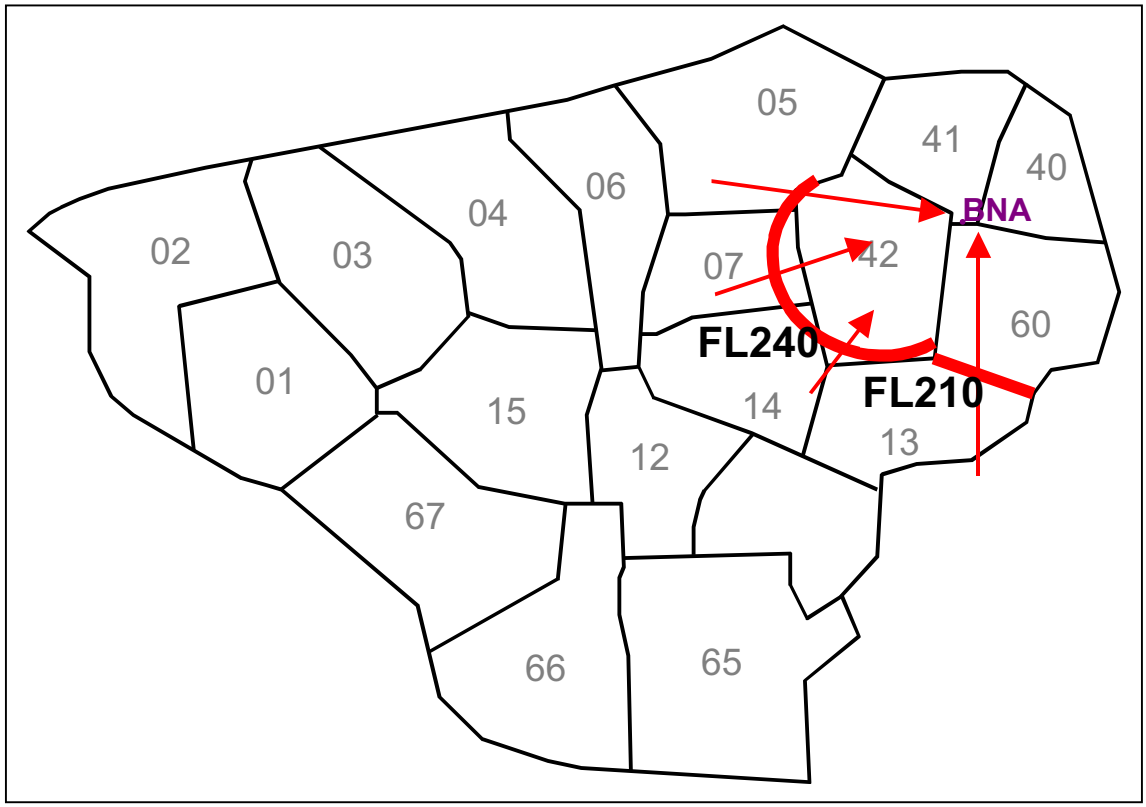

Figure 4-2. Memphis Intra-Facility Nashville Arrival Restrictions: March 2000

During the period 13 March through 11 April, all intra-facility Nashville arrival restrictions were turned off in URET and the controllers did not issue the restrictions to the aircraft.

Unfortunately, removal of these restrictions did not provide benefits to NAS users. There were no aircraft that crossed from the south, sector 13 to 60, during the time that CAASD did the analysis. The lifting of restrictions to the west and north of Nashville did not provide a benefit to users as pilots had to descend their aircraft to FL240 or below to meet the crossing restriction at the approach control. From a controller perspective the restrictions were not required to manage traffic. The ZME URET Procedures and Benefit Team met on 6 April and decided to recommend removal of the Nashville arrival restrictions permanently, based on the results of the test up to that point.

4.1.1.3 ZID: Indianapolis Arrivals – April Evaluation

During the first two weeks in April, the ZID Procedures and Benefits team evaluated the lifting of two restrictions. All arrivals into Indianapolis crossing from sector 18 to 34 are normally required to cross at 15,000 feet 25 nmi north of ABB. Jet aircraft going to Standiford, the airport for Louisville, from sector 35 to 17 are normally required to cross at 15,000 feet or below (see Figure 4-3). These two restrictions were lifted at the same time.

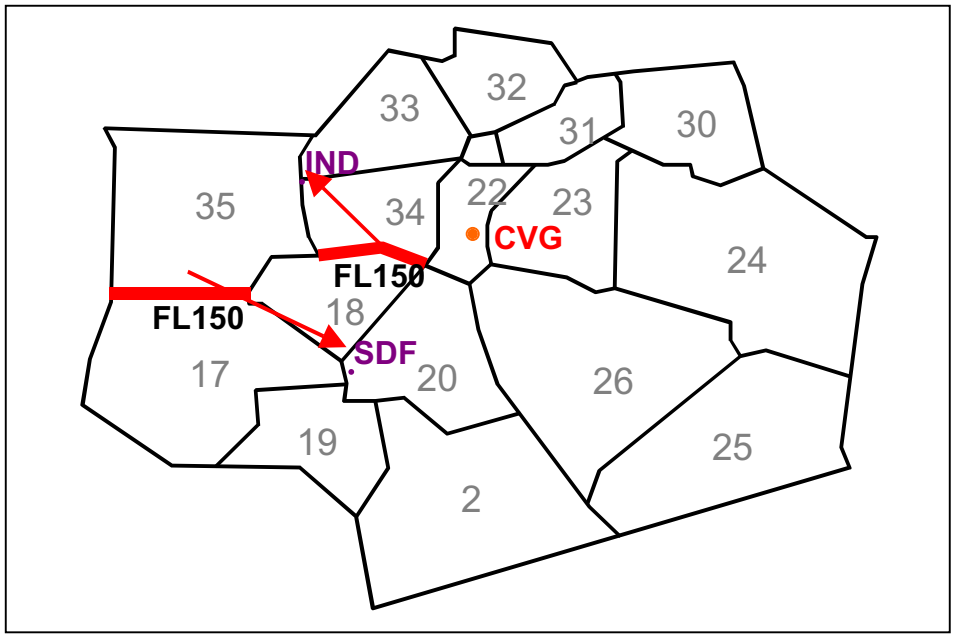

Figure 4-3. Indianapolis Altitude Restriction Evaluation: April 2000

After the two-week period, the Team reimposed the restrictions and evaluated the results. The ZID Procedures and Benefits Team determined that lifting the Indianapolis arrival restriction caused problems with Cincinnati departures to the west. The departures either had to be sped up or vectored around the Indianapolis arrivals. Given the increased complexity of the traffic and the penalty imposed on Cincinnati departures, the Team decided that it was necessary to maintain the Indianapolis arrival restriction. The restriction into Standiford was reinstated after two weeks and is currently being evaluated. The Team will decide at their next Team meeting whether the restriction should be required, modified, or permanently removed.

4.1.1.4 ZID: Pittsburgh Arrivals

The ZID Procedures and Benefits Team decided at their May meeting to permanently raise the arrival restriction into Pittsburgh from sector 83 to sector 85 from FL 290 to FL330. The action becomes effective on 21 May 2000. The crossing boundary is approximately 210 miles from the airport (see Figure 4-4). This action was not a direct result of any URET test. This crossing was to be evaluated in June. However, prior to the planned evaluation, controllers and supervisors involved stated that since they have URET probing the airspace, they don't need to "miss airspace" (i.e., keep the Pittsburgh arrivals below other traffic in order to separate streams of traffic from each other). According to site personnel, the workforce realized how effective URET is in this type of situation, and decided to raise the restriction immediately without waiting for the planned June evaluation.

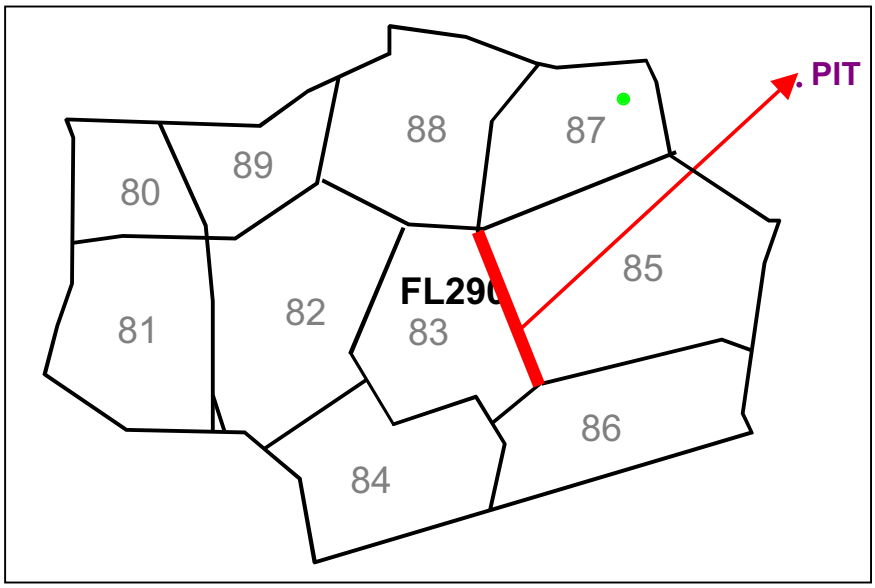

Figure 4-4. Pittsburgh Altitude Restriction Removal: May 2000

A run of the Analysis and Restriction Tool (ART) on 6 April indicated that 9 aircraft crossed from sector 83 to 85 and stayed at altitude an average of 88.5 nmi longer. The fuel penalty was estimated at 25 gallons per aircraft, based on the fuel burn rate of a 737-800.

US Airways reported that removal of this one sector crossing restriction for Pittsburgh arrivals permitted arrivals from the southwest to remain at FL330 for an additional 88 miles. They determined through test flight plan analysis and consultation with their fuel optimization engineer that reduced fuel consumption for eight daily Pittsburgh arrivals from Dallas and Houston equates to an annual savings of $126,630.

4.1.2 Airline Participation

The ZID Procedures and Benefits Team invited airline participation in their meetings on a regular basis. The first meeting was held in January of this year; the second meeting was held in April. Meetings will be held on a quarterly basis. The purpose of these meetings is to:

- Provide airlines with a better appreciation of traffic management requirements
- Acquaint the carriers with the capabilities of the URET DU system as an enabler for operational personnel to provide benefits to NAS users
- Provide operational personnel with a better understanding of airline requirements
- Enlist the support of airlines in quantifying the benefits work that ZID operational personnel have undertaken

The two meetings to date have been very successful. At the first meeting eight airlines were represented: Delta, Northwest, Comair, Southwest, US Airways, United, Ryan International, and UPS. Airline personnel were given a tour of the control room in order to observe URET in use by control personnel. It was their first exposure to URET. Each member of the URET team presented a brief overview of his area, in order for airline personnel to better understand the traffic flows. Team members also explained how URET is utilized in different situations to aid the controller in the decision making process. They also explained how much easier URET has made the job of managing the manual control position.

At the second meeting in April, all of the above airlines except Southwest sent representatives. Members of the ZID Procedures and Benefits Team and FFP1 Program Office asked the airline representatives which restrictions were most burdensome to them. The Procedures and Benefits Team wants to know which restrictions most impede traffic, from an airline perspective. The FFP1 Program Office is planning to do a restriction inventory one year before URET is deployed at the FFP1 sites. They also would like to know which restrictions the airlines find most onerous.

The collaboration of ZID operational personnel and airline representatives is very promising. Both groups are developing a better understanding of each other's problems. The airlines are getting an understanding of how the strategic capabilities of URET help controllers manage traffic. The two groups are working toward a common goal of increasing benefits to users of the NAS while maintaining safety.

Section 5

Fuel Burn Analysis

To determine the economic impact on the airlines of removing static altitude restrictions requires the knowledge of the miles gained en route at more efficient altitudes, the type of aircraft affected, and the fuel burn differential for the altitudes involved. This data can then be combined and extrapolated to yield an estimate of the gallons per year of jet fuel saved, which can be converted to dollar savings with an estimate of the average dollar per gallon fuel cost.

5.1 Determination of Flights Affected by a Particular Restriction

The primary tool used to analyze the number of flights subject to each restriction is the ART tool built at CAASD. The ART tool provides data on which restrictions impact traffic the most.

For a given sample set, ART determines how many aircraft are eligible for a given set of restrictions, how long the aircraft stay at the restricted altitude, and other statistics. Using this information, the ART output can be used to determine which restrictions have the most impact on ATC and airline operations.

ART uses the URET trajectory to first determine if a flight is eligible for a restriction. A flight must match the following criteria:

- Aircraft's type (e.g., B727) must match the restriction type criteria (Jet, conventional, or all).
- Aircraft's filed altitude must be above restriction altitude.
- Aircraft's destination (departure) airport must match arrival (departure) restriction airport.
- Aircraft's route of flight must cross the boundary associated with the restriction. For example, a restriction applying to all arrivals from the south would have a boundary line south of the airport. Arrivals from the north would thus not cross this line and this restriction would not be applied to arrivals from the north.

Aircraft must cross boundary during the time that the restriction is in effect. Most static restrictions are not in effect during midnight operations.

5.2 Calculation of Penalties Incurred Due to the Restriction

5.2.1 Detailed Analysis

Restrictions were selected from the complete set of ZID restrictions for a detailed analysis. The selection criteria were for the number of aircraft effected by the restriction and the severity of the impact of the restriction on the effected aircraft. Originally six restrictions were chosen; this was eventually expanded into nine restrictions under study. Table 5-1 contains the results of an ART run made on 20 hours of ZID data for 26 May 1999. The significant data in this table is for each restriction selected; the table gives the number of aircraft affected by the restriction, and the average number of miles the aircraft remained at the restriction altitude. This distance is a measure of the distance at which the aircraft flew at a lower, less efficient altitude, because of the restriction.

Table 5-1. Impact of ZID Restrictions Analyzed

Restriction Number	Type	Restriction	Number of Flights	Average Path Length
A.26	A	CVG_A_81/82_240	83	21.1
A.17.1	A	CVG_A_87/23_VIA_BOWRR_240	79	20.4
A.21	A	CVG_J_35/34_170	74	21.8
A.23	A	CVG_A_84/83_VIA_DRESR_240	64	28.6
A.25	A	CVG_A_80/35_VIA_JEANE_240	58	25.8
A.24	A	CVG_A_85/83_VIA_50_W_HNN_240	44	5
A.01	A	BNA_A_80/81_290	4	80.9
A.37	A	IND_A_87/88_310	6	13.9
A.36	A	IND_A_84/82_310	10	45.6

To determine the fuel penalty incurred due to the restrictions the distribution of aircraft types and the fuel burn at different altitudes for each aircraft type is required. Table 5-2 is the distribution of aircraft types for the original six restrictions studied. The aircraft type most often affected was the Canadair Regional Jet (CARJ). This occurs because Cincinnati (CVG) is a hub for Comair, which is a regional airline using CARJs. Airlines provided a limited amount of data concerning the fuel burn of the CARJs. They also provided fuel burn at various altitudes for Boeing 727,737-800,737-300,757,767 and MD88s. This data was normalized to the fuel penalty per mile compared to fuel burn at FL350 and plotted. Figure 5-1 is the combined plot of the fuel penalties in pounds of fuel per nautical mile flown at the less efficient altitude. Note that the CARJ normally does not operate above FL290; therefore its penalty goes to zero at FL290.

The data in this figure can be used two ways to evaluate the impact of a restriction on a particular flight. If the desired FL for that flight is known, subtract the penalty for the desired FL from the penalty for the restriction FL. This is the net penalty for imposing that restriction on that flight. If the desired FL is not known, use the penalty for the FL of the restriction directly. This will give an upper bound on the penalty incurred from invoking the restriction. For example, for a Boeing 737-300 the fuel penalty for FL310 compared to FL350 is 1.2 pound per nmi, and the penalty for FL 240 is 2.6 pounds per nmi. A flight that has filed for FL310 that is subject to restriction A.26 (see Table 5-1) will fly 21.1 miles at the less efficient altitude. The penalty is the difference of the penalties for each FL (2.6-1.2) times the miles flown; (i.e., 1.4*21.1) for a total penalty of 29.5 pounds of fuel.

The data from Table 5-1 for the average path length flown at the restriction altitude, combined with the distribution of the aircraft affected and fuel burn at the restriction altitude for each aircraft is the basis for the estimate of the fuel penalty incurred for each restriction for one day. Note that there were only distributions available for the first six restrictions. It was assumed the distributions for the other three restrictions were similar. These daily penalties can be multiplied by 365 to estimate the yearly penalty. Table 5-3 contains the result of that calculation in pounds and gallons.

5.2.2 Other Analyses

High level analyses were conducted to determine an order of magnitude estimate of the impacts of other classes of restrictions. Table 5-4 contains the results of an analysis of all the restrictions effecting aircraft crossing the boundary between ZME and ZID. Fuel savings were estimated using the data for the Boeing 737-800. Figure 5-1 indicates that the Boeing 737 gives conservative estimates for the fuel burn of the effected aircraft. A complete analysis would be expected to indicate even higher fuel penalties.

Order of magnitude analyses were conducted for all the restrictions in ZID. It was determined that for the 124 restrictions above FL240 the total fuel penalty per year was 2.4 million gallons. For the 16 restrictions at FL240, the yearly fuel penalty was 1.4 million gallons. For the 205 restrictions below FL240, the yearly fuel penalty was 7.5 million gallons.

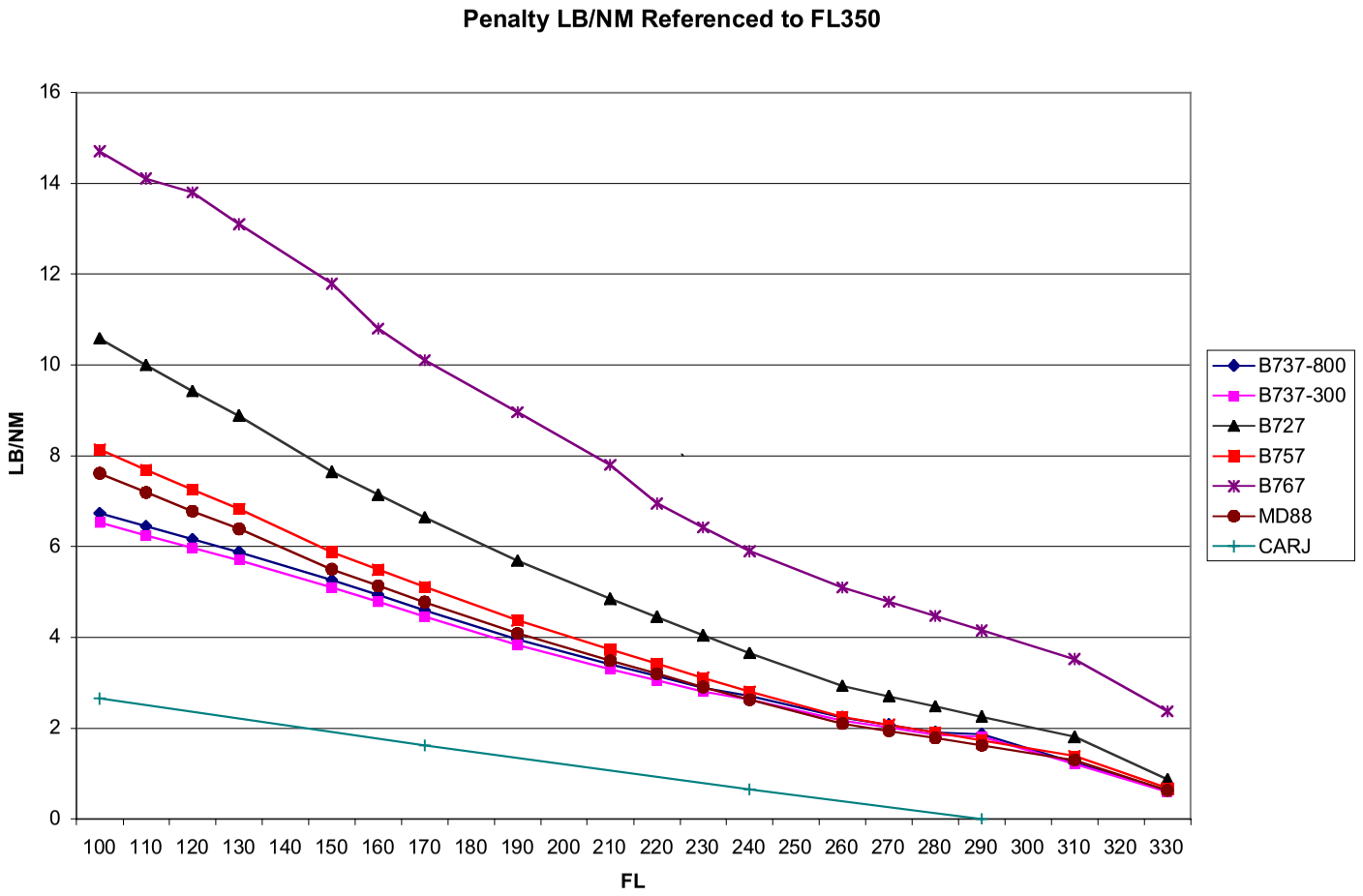

Figure 5-1. Fuel Penalty Reference to FL350

Table 5-2. Aircraft Distribution

	737	757	767	727	MD80	CAR J	E145	Lears	L1011	MD11	MD90	Others	Total
A.26	7	6	2	9	14	32	2	2			1	8	83
A.17.1	5	8	3	6	15	41	1	0				0	79
A.21	6	2	1	11	10	34	4	0	1	1		8	78
A.23	1	8	2	4	14	31	0	1	1			2	64
A.25	3	1	1	8	7	32	0	0	1	1		4	58
A.24	6	5	1	6	6	16	1	0	0			3	44
Total	**28**	**30**	**10**	**44**	**66**	**186**	**8**	**3**	**3**	**2**	**1**	**25**	**406**

Table 5-3. Fuel Penalty per Restriction Table

Restriction Number	LB/Day	LB/Year	Gal/Year
A.26	3861	1336441	199469
A.17.1	2948	1075947	160589
A.21	5830	2128020	317615
A.23	3416	1246939	186110
A.25	2621	956767	142801
A.24	476	173795	25940
A.01	557	203156	30322
A.37	84	30695	4581
A.36	669	244334	36468
Total	20263	7396094	1103895

Table 5-4. ZME/ZID Penalties from Restrictions

		ZME/ZID Restrictions	Penalty in Pounds			
			Per nmi	Per Flight	Per Day	Per Year
D12.5	A	EVV_A_ZME/EVV_110	6.42	162	1132	413358
G.25	D	BNA_A_ZME63/82_V_J39(IIU)_290	1.872	14	416	151688
G.23	D	BNA_A_ZME62/84_V_J42_270	2.078	14	198	72206
C.22	A	CVG_A_ZME/81_330	0.6236	25	305	111440
C.25.2	A	SDF_A_ZME/19_SWEWO_250KT_11	6.42	102	715	260809
GP.03	D	BNA_A_ZME41/19_BNA-CP_230	2.9	0	0	0
G.24	D	BNA_A_ZME63/84_V_J39(IIU)_290	1.872	0	0	0
GP.04	D	BNA_A_ZME40/19_BNA-CP_230	2.9	0	0	0
C.23.1	A	EW_A_ZME/19_230	2.9	143	285	104156
C.25.1	A	SDF_A_ZME/19_SW_EWO_110	6.42	103	205	74986
C.24.2	A	LEX_A_ZME/82_270	2.078	53	53	19417

Section 6

Next Steps

The expansion of URET to seven contiguous sites provides opportunities for the achievement of extensive benefits. This section describes some future work that the FFP1 Program Office plans to undertake to expand user benefits. It also addresses the work that the FFP1 Office, with the assistance of CAASD, is doing to formalize the methodology that is evolving at ZID and ZME to provide benefits to NAS users. The plan is to transfer the methodology to the other FFP1 URET sites.

6.1 Future Benefits Work

The expansion of URET to seven contiguous sites provides opportunities for more extensive benefits work. The work to date has focused on relaxation of static altitude restrictions. In addition to altitude restrictions, there are preferred routes that are flown between city pairs and through large blocks of airspace that do not correspond to any single facility boundary. Some of these routes can be circuitous causing additional flying time and distance. CAASD will assist the FFP1 Program Office in analyzing these routes to determine if more direct routings can be granted with URET FFP1 in operation.

Another future area for investigation concerns the relationship among the routes airlines would prefer that their aircraft fly, the routes that airlines actually file, and the routes that the aircraft end up flying. A still unanswered question for future investigation is whether airlines file flight plans that reflect what they would like to fly. Do the flight plans reflect the routes desired by the airlines or the routes that the airline dispatcher considers the best route given the known constraints? And how often is the filed route actually flown without a flight getting rerouted?

6.2 Transfer of Methodology for Benefits

During the 2001-2002 timeframe, FFP1 URET will be deployed at all seven sites. By the time the new sites approach operational usage, a plan for evaluating restrictions for relaxation and possible removal within those facilities will already be in place.

The methodology under development includes:

- Working with operational personnel to identify and evaluate restrictions and to optimize the use of URET
- Working with the airlines to determine what restrictions it would most benefit them to relax
- Performing the data analysis to help identify restrictions for evaluation (before the fact) and to analyze the impact of restriction relaxation (after the fact).

6.2.1 Coordination with Operational Personnel

The FFP1 Program Office and CAASD are jointly working with operational personnel at ZID and ZME to develop a set of URET recommended operational 'practices' in the use of URET. The goal is to maximize benefits and increase the operational utility of URET. The recommended operational practices will be used in the development of the training program for the future FFP1 URET sites.

The FFP1 Program Office, with CAASD's assistance, will continue to work with the Procedures and Benefits Teams as their processes evolve and they learn more about the necessary conditions for lifting restrictions. The Teams are currently lifting some intra-facility restrictions and evaluating the results. Their work will expand to address inter-facility restrictions between ZID and ZME (the two URET sites), and, possibly, outbound restrictions to non-URET Centers. The experience gained and "lessons learned" by the Procedures and Benefits Teams will be factored into the development of the methodology for benefits achievements at the new URET sites.

One year before deployment, The FFP1 Program Office is planning to review airspace altitude restrictions at the new FFP1 URET sites to determine which restrictions have the greatest impact on flights and which of these each facility thinks can be removed.

6.2.2 Coordination with Airlines

The FFP1 Program Office will continue the ongoing dialogue with the airlines. The airlines now meet quarterly with the ZID Procedures and Benefits Team. At the last NAS Users Day meeting in April, members of the FFP1 Program Office asked the airline representatives for a list of restrictions at all seven FFP1 URET sites that most impede traffic from an airline perspective. The Program Office intends to consider the airline input in conjunction with the list of restrictions that the sites develop to identify restrictions for future testing and possible removal.

The airlines are the biggest benefactors of the ongoing restriction relaxation work. They have been very helpful in quantifying the benefits by providing the FFP1 Program Office and CAASD with fuel burn data by aircraft type at various altitudes. FFP1 personnel will continue to work with the airlines to enlist their support in future efforts to quantify savings in time, distance and fuel burn.

6.2.3 Data Analysis

The ongoing FFP1 URET metrics and benefits work will continue at both ZID and ZME. The monthly data analysis and reports have expanded to provide more information on the benefits for NAS users. CAASD has recently added the following reports to its standard monthly output:

- Savings from Directs: Savings in distance that aircraft travel resulting from the controller clearing aircraft direct via URET to downstream fixes
- Lateral Distance Saved: Distance saved from all lateral amendments (including directs as well as penalties), the average of the daily sum of nautical miles changed
- Unique Alert Counts (Measure of Complexity): The count of the highest color a unique URET alert reached; weekday average

Using the ART tool, CAASD will continue to provide input on candidates for restriction relaxation. CAASD will also continue to evaluate the benefits resulting from lifting specific restrictions. In addition, CAASD is developing two other sets of tools.

- Trajectory analysis tools that analyze the change in the trajectory due to the restriction, as if the aircraft were the only aircraft in the sky. The changes examined in the trajectory include change in time of arrival, distance between TOD points with/without arrival restriction, distance between top of climb (TOC) points with/without departure restriction, and difference in altitude between filed altitude and restriction altitude.
- System impact tools that look at the impact on the center when a restriction is lifted. These tools include before and after restriction(s) removal checks on sector density and conflict count. Sector density is measured by counting aircraft volume in a sector. The center conflict counts look at the change in the number of conflicts found by the conflict probe, at the aggregate center level to determine if conflict count changes significantly due to restriction removal.

List of References

Celio, J. C., Bowen, K. A., Winokur, D. J., Lindsay, K. S., Newberger E. G., Sicenavage, D., January 2000a, *Free Flight Phase 1 Conflict Probe Operational Description,* MTR 00W0000100, The MITRE Corporation, McLean, VA.

Celio, J. C., Walker, M. G., McFarland, A. L., July 2000b, *User Request Evaluation Tool (URET) Benefits During Free Flight Phase 1,* MP99W0000183, The MITRE Corporation, McLean, VA.

Ricker, M. L., Walker, M.G., May 1999, *Evaluation of Altitude Restriction Relaxation for Standiford and Nashville Arrivals using URET*, WN 99W0000055, The MITRE Corporation, McLean, VA.

Walker, M.G., Lowry, N., January 2000, *URET Daily Use Metrics and Benefits Analysis – First Report 2000,* WN00W0000004, The MITRE Corporation, McLean, VA.

Glossary

AM	Amendment
ART	Analysis of Restrictions Tool
ARTCC	Air Route Traffic Control Centers
ATC	Air Traffic Control
BNA	Nashville
CAASD	Center for Advanced Aviation System Development
CARJ	Canadair Regional Jet
CCB	Configuration Control Board
CHI	Computer Human Interface
CVG	Cincinnati
DR	Discrepancy Report
DSR	Display System Replacement
DSS	Decision Support System
DU	Daily Use
FAA	Federal Aviation Administration
FFP1	Free Flight Phase 1
GPD	Graphic Plan Display
MIT	Miles-in-Trail
NAS	National Airspace System
NATCA	National Air Traffic Controllers Association
NRP	National Route Program
RJ	Regional Jet
SDF	Standiford
SUA	Special Use Airspace
TMU	Traffic Management Unit
TOC	Top of Climb
TOD	Top of Descent
TPs	Trial Plans
URET	User Request Evaluation Tool
ZID	Indianapolis
ZME	Memphis