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Summative Evaluation of the Collegiate Training Initiative for Air Traffic Control Specialists Program: Progress of Minnesota Air Traffic Control Training Center Graduates in En Route Field Training

Dana Broach

Civil Aeromedical Institute
Oklahoma City, Oklahoma 73125

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16. Abstract

This summative evaluation of the Collegiate Training Initiative for Air Traffic Control Specialists focused on the progress of the Minnesota Air Traffic Control Training Center (MnATCTC) graduates in en route field training. The evaluation compared 136 MnATCTC graduates with 157 FAA Academy graduates on 4 classes of measures: (a) diversity; (b) progress in training at the first assigned field facility; (c) attrition from the first assigned field facility; and (d) performance ratings at the first assigned facility. A cost-benefit analysis for the MnATCTC program was also conducted. There were significantly more women in the MnATCTC (40%) than in the FAA Academy group (17%); there were no significant differences in minority representation. Just 17% of the MnATCTC had achieved full performance level (FPL) certification as of June 1995, compared with 69% of the FAA Academy group. However, time to FPL and attrition rates were similar. MnATCTC graduates were rated significantly lower than FAA Academy graduates by supervisors in teamwork, technical skill, technical knowledge, and overall potential to succeed in the ATCS occupation. Cost analysis found that MnATCTC per-hire costs would be competitive with FAA Academy costs-per-student by FY1998–2000. Cost-benefit analysis found that the MnATCTC would begin returning about $1.45 in avoided costs and savings to the agency for every $1 invested by FY1998–2001, even with continued FAA financial support. However, with a maximum capacity of about 100 graduates per year, the MnATCTC can provide only a small fraction of the FAA controller workforce. In summary, this evaluation found that the MnATCTC program appears to be achieving its stated goals.

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EXECUTIVE SUMMARY

Overview

This first summative evaluation of the Collegiate Training Initiative for Air Traffic Control Specialists (CTI/ATCS) focused on the progress of Minnesota Air Traffic Control Training Center (MnATCTC) graduates in en route field training. The evaluation was framed by two questions:

- How are MnATCTC program graduates progressing in en route field training relative to a comparison group of FAA Academy graduates?
- What are the costs and benefits of the MnATCTC program for the Federal Aviation Administration (FAA)?

Method

The evaluation compared 136 MnATCTC graduates hired between 1990 and 1993 with 157 FAA Academy graduates who entered en route field training in May and June 1991. The groups were compared on 4 measures:

- Diversity
- Progress in en route field training at first assigned en route facilities
- Attrition from first assigned en route facilities
- Performance ratings at first assigned en route facilities

Supervisory, on-the-job training instructor (OJT-I), and self-evaluations were collected in spring 1994 by mail. Field training and attrition measures were extracted from FAA and Civil Aeromedical Institute (CAMI) databases in June 1995.

Direct and indirect costs associated with the MnATCTC program were estimated and projected through the year 2003 to compare per-hire costs with FAA Academy per-controller costs. Four classes of monetary benefits to the agency were identified: (1) avoided screening costs; (2) avoided Academy training costs; (3) avoided performance verification (PV) costs; and (4) savings from reduced time-to-FPL for MnATCTC graduates. Program benefits were estimated and projected through the year 2003 to conduct a benefit-to-cost analysis for the MnATCTC program as a model for future CTI/ATCS cost-benefit analyses.

Results

Diversity

There were significantly more women in the MnATCTC group (40%) than in the FAA Academy sample (17%). There was no difference in the representation of minorities.

Field training progress

Training phases. MnATCTC graduates did better on six measures of training performance, relative to historical facility averages: number of days to complete PHASE VII; number of days to complete PHASE IX (raw and adjusted for the number of sectors for which training was provided); number of days in PHASE X (raw and adjusted for number of sectors for which training was provided); and number of days in PHASE XI. FAA Academy graduates did better than MnATCTC graduates on three measures of training performance, relative to historical facility averages: indicator of performance (IP) ratings in PHASE VI; number of days in PHASE VIII; and number of hours of on-the-job training (OJT), adjusted for number of sectors, in PHASE X.

Time to FPL. Just 23 of the MnATCTC graduates (17%) had reached FPL at the first assigned field facility as of June 1995, in contrast to 108 of the FAA Academy graduates (68.8%). There was no significant difference in the average times to FPL between the groups. Survival analysis found no significant differences between the groups in accession to FPL over time.

Attrition

Ten developmentals had attrited at the first assigned facility from the MnATCTC group, compared with six FAA Academy graduates. The attrition rates were not statistically different. Significantly more MnATCTC graduates ($N = 7$) had changed facilities or options than FAA Academy graduates ($N = 1$; $Z = 1.99$, $p \leq .05$). No significant differences between groups in attrition over time were found by survival analysis.

Performance ratings

Supervisors rated controllers on items representing five dimensions: (a) technical skill; (b) technical knowledge; (c) teamwork; (d) degree to which the developmental was accepted by others in the facility; and (e) global assessment of potential to succeed in the ATCS occupation. MnATCTC graduates were rated significantly lower than FAA Academy graduates on all five dimensions. In particular, the average rating on potential to succeed in the occupation of 81 for MnATCTC graduates was significantly lower than the average rating of 86 for FAA Academy graduates (on a 40 to 100 scale).

Controllers completed a self-evaluation using the same instrument as supervisors. MnATCTC graduates rated themselves significantly lower on teamwork, technical skill, technical knowledge, and potential to succeed in the ATCS occupation than did FAA Academy graduates. MnATCTC graduates also felt significantly less well accepted at the facility than FAA Academy graduates.

Program costs and benefits

The comparison of MnATCTC per-hire costs with FAA Academy per controller costs found that the MnATCTC per-hire costs would be equal to or less than FAA Academy per controller costs by the FY1998-2000 timeframe.

The benefit-to-cost analysis found that the MnATCTC program would begin returning a dollar or more for every dollar invested in the program by the FY1998-2000 timeframe, given current hiring projections, even with continued FAA financial support of about $1.5 million per year to produce 100 new graduates each year.

Capacity relative to projected demand

The MnATCTC has a maximum capacity, according to Congressional testimony by the program director, of producing 100 graduates per year with a continuing financial subsidy from the FAA. Analysis of current ATCS workforce demographics suggests a much larger hiring demand after the turn of the century. It is unlikely, therefore, that the MnATCTC can supply more than a small fraction of FAA workforce requirements.

Conclusions

Overall, the MnATCTC program appears to be meeting most of its stated objectives. The MnATCTC is contributing to agency diversity goals for women, but not minorities. The progress of MnATCTC graduates through field training is essentially no different than the progress of FAA Academy graduates. MnATCTC were rated significantly lower on five job performance dimensions than FAA Academy graduates. MnATCTC appears to be able to produce new controllers on a cost-competitive basis with the FAA Academy. FAA benefits accruing largely from avoided FAA Academy training costs are not likely to balance cumulative program costs in the near-term (FY1997-2000). Over the longer term, however, accrued FAA benefits may be greater than cumulative costs, even with continued FAA financial support. Alternative approaches that require little or no agency investment in and support of external training infrastructure at the cost of internal training capacity may yield greater rates-of-return, as well as satisfy larger proportions of the agency's future workforce requirements.

SUMMATIVE EVALUATION OF THE COLLEGIATE TRAINING INITIATIVE FOR AIR TRAFFIC CONTROL SPECIALISTS PROGRAM: PROGRESS OF MINNESOTA AIR TRAFFIC CONTROL TRAINING CENTER GRADUATES IN EN ROUTE FIELD TRAINING

INTRODUCTION

Comprehensive reviews of the Federal Aviation Administration (FAA) air traffic control specialist (ATCS) recruiting, selection, and training programs completed in the late 1980s (Schultz & Marshall-Mies, 1988; Means et al., 1988; Northern NEF, Inc., 1988) recommended that the agency rely more heavily on the technical training expertise available through two- and four-year colleges and universities. In response to those studies, the FAA developed the *Flight Plan for Training* (*Flight Plan*; Office of Training and Higher Education, 1989) in which the development of pre-hire controller training at the college and/or university level was identified as a specific initiative (p. 28):

> Pre-hire training at the college and university level will provide an economical new source of highly qualified and motivated Air Traffic Control Specialists. To test this concept, a trial Air Traffic Control (ATC) training program will be conducted. A university-based pilot program in which one hundred controllers will earn undergraduate degrees and receive the equivalent of the FAA Academy's developmental training will be initiated in 1989. If hired by the agency, these controllers will enter the FAA training system at an advanced level. The agency will expand this program to other universities and colleges if the experimental program is successful.

Program implementation

Implementation of this concept began in 1989, with approval and funding for two programs: the Minnesota Air Traffic Control Training Center (MnATCTC), as administered by the Mid-America Aviation Resource Consortium, Eden Prairie, Minnesota; and Hampton University, Hampton, Virginia. The program was subsequently expanded under the direction of the Higher Education and Advanced Technology Staff (AHT-30), culminating in the 1991 FAA Order 3120.26. The order formally established the Collegiate Initiative for Air Traffic Control Specialists (CTI/ATCS) as a test program and provided for the selection of participating educational institutions. By 1992, five institutions were participating in the CTI/ATCS program:

- The Minnesota Air Traffic Control Training Center (MnATCTC), Eden Prairie, Minnesota, as administered by the Mid-America Aviation Resource Consortium (MARC);
- Hampton University (HU), Hampton, Virginia;
- Community College of Beaver County (CCBC), Monaca, Pennsylvania;
- University of North Dakota (UND), Grand Forks, North Dakota; and
- University of Alaska at Anchorage (UAA), Anchorage, Alaska.

However, full implementation of the program coincided with a significant downturn in ATCS hiring requirements in 1992 and 1993 (Morrison, Fotohui, & Broach, 1996), resulting in a lower rate of hiring of CTI/ATCS program graduates than had been expected. The Office of the Inspector General for the Department of Transportation (DOT/IG) conducted an audit of FAA higher education programs at about the same time. That DOT/IG (1993, p. 14-15) recommended that the FAA discontinue future funding for the CTI/ATCS program and advise the appropriate congressional committees of the program's limited success, absence of hiring opportunities for program graduates, and intention to recommend discontinuance of the program. However, the FAA formally disagreed with the DOT/IG recommendations on the CTI/ATCS program, pending an evaluation of the long-range recruitment need for air traffic control specialists. Moreover, at the time of the DOT/IG audit, only a few (61) CTI/ATCS program graduates had been hired by the FAA from the MnATCTC program. Since that date, the number of graduates from MnATCTC and other participating institutions hired by the FAA has increased substantially (Table 1), providing a larger sample to support an empirically based summative evaluation. As shown in Table 1, the largest number of CTI/ATCS graduates hired by the FAA has come from the MnATCTC program. In addition, the MnATCTC program has been a subject in budget negotiations between the Congress and the FAA since FY94. Therefore, this report focuses specifically on the MnATCTC program in an empirical evaluation of goal attainment relative to agency hiring requirements, costs, and benefits.

Evaluation design

Evaluations can be broadly categorized into three classes, based on the primary focus of the research: (a) program conceptualization; (b) program implementation; and (c) program utility (Rossi & Freeman, 1985). The formative evaluation conducted in fiscal year 1993 (Morrison, Fotohui, & Broach, 1996) concentrated on program implementation at each of the five participating educational institutions. That evaluation specifically addressed the degree of innovation that the five participating institutions demonstrated with regard to their (a) recruiting activities, (b) selection procedures, and (c) training methods. Overall, the participating institutions, including MnATCTC, had developed recruiting, selection, and training methodologies and technologies that differed substantially from those used by the FAA. This summative evaluation addresses outcomes, with particular attention to the MnATCTC program. MnATCTC graduate diversity and performance in field facility training is compared with that of a control group of FAA Academy graduates.

It should be noted that the control group in this evaluation is not strictly equivalent to the "experimental" group of MnATCTC graduates. For example, the control group is not drawn from the same en route facilities to which MnATCTC graduates were assigned (Table 2). A third of the MnATCTC graduates were assigned to the Minneapolis Air Route Traffic Control Center (ARTCC); another 20% were assigned to the Oakland ARTCC. In contrast, the control group of FAA Academy graduates were scattered across 20 of 23 en route centers (excluding Guam). Nor is the control group matched to the MnATCTC graduates in terms of hiring dates (Table 3). The control group entered field training in mid-1991, while the MnATCTC graduates entered service from late 1991 through 1993. As a consequence, the control group had been at the first assigned en route facility an average of 38 months (SD = 11.3 months), compared with 28 months (SD = 9.32 months) for the MnATCTC graduates ($F(1,291) = 71.80$, $p \leq .001$), as of June 1995. Therefore, the research design can be characterized as a post-treatment comparison with a non-equivalent control group, which is considered a relatively "weak" design in terms of controls for validity and generalizability (Campbell & Cook, 1976). However, this design does provide at least some objective data as the basis

Table 1. CTI/ATCS Hiring by fiscal year and participating institution[a]

	Participating Institution					
FY	MnATCTC	HU	CCBC	UND	UAA	Total
88-90[b]			3			3
91	26		10			36
92	19		2			21
93	78		18			96
94	40	1	0	7	5	53
95	30	14	35		1	80
96		17	6		6	29
Total	193	32	74	7	12	318

Notes: [a]Data provided by Aviation Careers Examining Division (AMH-300)
[b]FY88-90 CCBC Cooperative Education Program graduates counted as CTI/ATCS hires

Table 2. Air Route Traffic Control Center (ARTCC) assignments by program

		MnATCTC		FAA Academy	
FACID	Name	*N*	%	*N*	%
ZAB	Albuquerque			9	5.7
ZAN	Anchorage	7	5.1		
ZAU	Chicago			10	6.4
ZBW	Boston			2	1.3
ZDC	Washington	1	0.7	8	5.1
ZDV	Denver			11	8.1
ZFW	Fort Worth	5	3.7	12	7.6
ZHN	Honolulu			2	1.3
ZHU	Houston			11	7.0
ZID	Indianapolis	5	3.7	7	4.5
ZJX	Jacksonville	1	0.7	8	5.1
ZKC	Kansas City	18	13.2		
ZLA	Los Angeles	2	1.9	3	1.5
ZLC	Salt Lake City	1	0.7	7	4.5
ZMA	Miami			15	9.6
ZME	Memphis	3	2.2	16	10.2
ZMP	Minneapolis	46	33.8	11	7.0
ZNY	New York City	2	1.5	12	7.6
ZOA	Oakland	1	0.6	27	19.9
ZOB	Cleveland			11	7.0
ZSE	Seattle			9	5.7
ZSU	San Juan CERAP	1	0.7		
ZTL	Atlanta	6	4.4	3	1.9

for assessing MnATCTC program goal attainment, costs, and benefits relative to the known standard of FAA Academy graduates.

Goals, costs, and benefits should be operationally defined in evaluation research such as this study (Bloom, 1967; Rossi & Freeman, 1985). Specific operationally-defined criteria for the summative evaluation of the MnATCTC program relative to traditionally hired and trained FAA Academy graduates included (a) increased employee diversity, (b) improved employee performance as represented by instructor, self, and supervisor evaluations, (c) reduction in time for graduates of these programs to complete the ATCS field training sequence, and (d) reduction of attrition during field training among MnATCTC graduates. The latter two operational criteria, along with specific incurred and avoided costs associated with the program, provide a basis for assessing the relative benefits of the initiative.

METHOD

Sample

Two groups of controllers were identified as the sample for this evaluation: 136 MnATCTC graduates hired by the FAA between 1991 and 1993 (see Table 3 for hiring dates), and the 157 FAA Academy graduates ("FAA Academy") that entered en route ATCS field training in May and June 1991. The FAA Academy graduates included persons who had participated in the development and validation of the FAA's ATCS Pre-Training Screen (Broach & Brecht-Clark, 1994). Facility assignments and hiring dates by program are presented in Tables 2 and 3. The overall demographic characteristics by program are described in Tables 4 (minority status and gender) and 5 (Equal Employment Opportunity (EEO) subgroups).

Table 3. Facility reporting dates by program

Reporting Date	MnATCTC		FAA Academy	
	N	%	*N*	%
May 1991			72	45.9
June 1991			83	52.9
September 1991	15	11.0	2	1.2
November 1991	11	8.1		
March 1992	16	11.8		
April 1992	1	0.7		
May 1992	3	2.2		
November 1992	2	1.4		
January 1993	27	19.9		
February 1993	3	2.2		
March 1993	11	8.1		
April 1993	2	1.5		
May 1993	12	8.8		
June 1993	11	8.0		
July 1993	2	1.5		
October 1993	1	0.7		
November 1993	10	7.3		
December 1993	6	4.4		
January 1994	3	2.2		

Table 4. Minority status and gender of evaluation sample

Characteristic	MnATCTC		FAA Academy		Total	
	N	%	*N*	%	*N*	%
			Minority status			
Nonminority	111	81.4%	136	86.6%	247	84.3%
Minority	12	8.8%	21	13.4%	33	11.3%
Missing	13	3.7%			13	4.4%
			Gender			
Male	82	60.3%	130	82.8%	212	72.4%
Female	54	39.7%	27	17.2%	81	27.6%
Missing						

Measures

Dependent variables, representing the criteria for this summative evaluation, included (a) representation by EEO group, (b) rate of progress in field training, (c) attrition from en route field training, (d) on-the-job training instructor (OJTI), self, and supervisor ratings of field performance, and (e) MnATCTC program costs and benefits.

Training progress

One means of achieving the goal of safe, orderly, and efficient operation of the National Airspace System is to ensure that the persons directing air traffic have reached the full performance level (FPL). FPL controllers are the backbone of the controller workforce, as they are responsible on a moment-to-moment basis for the safe, orderly, and expeditious flow of air traffic through the National Airspace System. Development of FPL skills and knowledge requires extended, intensive, and expensive formal and on-the-job training for trainee ("developmental") controllers. The training averages three years in en route centers (Manning, Della Rocco, & Bryant, 1989). This extended field training represents a significant agency expense directly proportionate to the time spent in training. For example, the Air Traffic Training Work Group (ATTWG; 1991a) in a comprehensive review of ATCS training programs, estimated field training costs at about $131,739 per en route controller over a 36-month interval. Innovative programs such as those offered at MnATCTC have the potential to reduce overall training times, thereby reducing the agency's costs. Similarly, attrition from the field training sequence represents a lost investment for the agency. Reductions in attrition rates, therefore, translate directly into cost savings.

Performance ratings

Evaluations of technical skill, knowledge, and teamwork provide additional information about core job performance not available in the training progress or attrition measures. Core technical job performance may be thought of as the product of knowledge, skill, and motivation (Campbell, 1990; Campbell, McCloy, Oppler, & Sager, 1993). Items to assess individual technical knowledge and skill were adapted directly from the existing instruments used for over-the-shoulder evaluation of technical performance (FAA Form 3120-25). Teamwork is a dimension of controller training and job performance that has become a recent focus of concern (Air Traffic Training Workgroup, 1991a,b; E. L. Hamm & Associates, Inc., & Hampton University, 1990; Hartel & Hartel, 1995; Newcomb & Jerome, 1994; Seamster, Cannon, Pierce, & Redding, 1992; Sherman & Helmreich, 1993). For example, teamwork was incorporated as an explicit evaluation dimension in the post-training performance verification process (Performance Verification Division, undated). Items representing teamwork in the evaluation instrument were based on a review of the teamwork and interpersonal skills literature with reference to air traffic control job analysis information (Stark, 1994).

In addition, concerns were raised by participating institutions that the degree to which a CTI graduate was accepted in the facility by co-workers, instructors, and management might influence OJT assignments, training, and perceptions of performance. Items were included, therefore, in the performance rating, to represent the degree to which the ratee felt or was perceived as being accepted in the workplace. Finally, a global subjective assessment of the ratee's potential to succeed in the ATCS occupation was incorporated into the performance rating instrument. Three parallel versions of the instrument were developed for first line supervisors, OJT instructors, and incumbent controllers. A sample of the OJT instructor, controller, and supervisor evaluation forms and associated cover letters are provided in Appendix A.

Benefits and costs

The training and survey data described above provide information about the degree to which the MnATCTC is meeting its program objectives, in terms of the progress and performance of program graduates, in comparison with controllers entering the occupation through the FAA Academy program. While knowledge, both of the manner in which a program such as the Minnesota program has been

Table 5. Representation of equal employment opportunity (EEO) groups

	MnATCTC		FAA Academy		Total	
Characteristic	*N*	%	*N*	%	*N*	%
Nonminority Male	66	48.5%	111	70.7%	177	60.4%
Nonminority Female	45	33.1%	25	15.9%	70	23.9%
Minority Male	9	6.6%	19	12.1%	28	9.6^
Minority Female	3	2.2%	2	1.3%	5	1.7%
Missing	13	9.6%			13	4.4%

implemented, and of its outcomes, is indispensable to program managers, stakeholders, and policymakers, it is just as critical in the evaluation process to provide information about costs relative to benefits (Rossi & Freeman, 1985). Inputs to the program and outcomes are measured in monetary terms in cost-benefit analyses to support program evaluation. Therefore, the final step in the evaluation was to develop a framework for measuring the costs associated with and benefits accruing from the CTI/ATCS program. That framework was then applied to the evaluation of the MnATCTC program as a model for future cost-benefit evaluations for each institution participating in the overall CTI/ATCS program.

Procedure

Field training progress data collection

Field training data for both samples were extracted from the Civil Aeromedical Institute ATCS Training Tracking (TRACKING) database. This database was maintained under the FAA ATCS National Training Tracking Program order (FAA Order 3120.22A; FAA, 1985) through June 1995. The phases of training are described in Table 6, based on the 1988 En Route Instructional Program Guide (IPG; FAA, 1988). There are variations allowed in the training phases, based on local facility requirements, as noted in Table 6. For example, PHASE VII (PRELIMINARY RADAR-ASSOCIATED/NONRADAR CONTROL TRAINING AND ASSISTANT CONTROLLER DUTIES) is conducted in the classroom for up to 8 weeks (40 days). The variation named PHASE VIIB adds 15 nonradar familiarization problems in the facility dynamic simulation laboratory ("DYSIM") to the classroom instruction. Other phases with variations include PHASE VIII (3 variations, differing in the total number and mix of nonradar and radar problems run in the DYSIM), PHASE XI (2 variations, differing in the total number of hours and DYSIM radar problems), and PHASE XIII (2 variations, differing in the total number of OJT hours allowed per sector). The sequences of phases and their variations (known as a "tracks" or curricula) taken by each controller, are summarized in Table 7. The majority of both MnATCTC and FAA Academy graduates followed either what is known as the "B-track" (substituting phases VIIB, VIIIB, XIB, and XIIIB for the standard phases VII, VIII, XI, and XIII), or what is called the "AB Standard" track, with phases VIIIA and XIB in place of the standard phase VIII and XI. A majority of the MnATCTC (53.7%) graduates followed the AB-Standard track, with a substantial minority (23.5%) following the B-track. In comparison, a plurality of FAA Academy graduates (42.0%) pursued the B-Track, with another 42.7% following the AB-Standard curriculum. Overall, despite the differences in facility assignments, the curricular tracks followed by graduates from the two programs (Academy, MnATCTC) are reasonably similar.

Training data available included the number of days spent in each phase of training, hours of on-the-job training (OJT) taken in each phase, and the overall rating of performance in that phase on a 1 (lowest 10% of controllers observed) to 6 (top 10% of all controllers observed) scale. The availability of data for subjects in each phase of training was entirely dependent upon the timeliness of reporting facilities; all data, as reported by the facilities, were extracted for this analysis. The reliability of the ATCS training tracking data has been described by Manning (1990). Incoming data were closely examined by CAMI research technicians for out-of-range and missing values; follow-up calls were made to the reporting facility as required to verify and complete data. The time-based measures (days in phase; hours of OJT) are ratio scale variables; any unreliability in those measures would be due to errors in reporting at the facility level, or to clerical errors in data handling. The reliability of the subjective assessment of developmental performance in a phase of training (the IP) is undocumented. However, studies of performance ratings in the literature suggest that such ratings are reasonably reliable and useful for a variety or workforce research purposes (Borman, White, Pulakos, & Oppler, 1991; Hoffman, Nathan, & Holden, 1991; Smith, 1976).

Attrition data collection

Data to identify attritions from training for both samples were extracted from the FAA Consolidated Personnel Management Information System (CPMIS) and cross-referenced with the CAMI ATCS Training Tracking (TRACKING) database. There is no single field in either data source indicating a training attrition; rather, multiple data elements from both sources must be evaluated and combined to determine the outcome for a given case. Outcome coding for this analysis was based on CPMIS and TRACKING data fields representing (a) grade level, (b) training phase

Table 6. En route training curriculum

Purpose	Length	Environment	Topics
PHASE V: Assistant Controller Training			
To prepare developmental for assistant controller position qualification and certification	40 days	Classroom	Center, area, and sector charts Flight data processing, including computer (HOST) message entries Interphone (land line) operation
PHASE VI: Assistant Controller Position Qualification/Certification			
Qualify developmental to perform full range of assistant controller duties and to obtain certification on all assistant controller positions of operation in an assigned area of specialization	80 hours per area	OJT	Receive, process, coordinate, and deliver flight plan information
PHASE VII (VIIB): Preliminary Radar-Associated/ Nonradar Control Training and Assistant Controller Duties			
To provide background knowledge in preparation for entry into radar-associated/ nonradar training	80 hours (15 Labs VIIIB)	Classroom DYSIM	Detailed area and sector chart Special military operations Letters of Agreement/facility orders Phraseology and strip-marking (Nonradar familiarization problems)

(Table 6 continues)

(Table 6 continued)

Purpose	Length	Environment	Topics
PHASE VIII (VIIIA, VIIIB): Radar-Associated/ Nonradar Controller Training			
To prepare developmental for initial radar-associated/ nonradar control position qualification and certification	56 hours 33 Labs (21 Labs - VIIIA) (42 Labs - VIIIB)	Classroom DYSIM	Strip-marking Interphone/radio phraseology and procedures Issue IFR and other clearances to provide vertical, longitudinal, or lateral separation according to priority to departing, arriving, and holding aircraft Position relief briefing Radar identification procedures and radar separation minima Apply procedures for verifying and using Mode C Apply transition procedures to and from primary back-up system
PHASE IX: Initial Radar-Associated/ Nonradar Control Position Qualification and Certification			
To qualify developmental to perform full range of duties and attain certification on 2 radar-associated/ nonradar control positions of operation in an area of specialization	180 hours per position (90 days max)	OJT	Initiate and accept radar handoffs and pointouts Perform appropriate changeover procedures to transition to and from primary back-up system Maintain separation using prescribed standards Issue departure clearances, beacon codes, holding procedures, weather advisories Emergency procedures: inflight emergencies, radio communication failure, hijackings Sector and board management

(Table 6 continues)

(Table 6 continued)

Purpose	Length	Environment	Topics
PHASE XIII (XIIIB): Final Radar Control Position Qualification and Certification			
To qualify developmental to perform full range of duties and attain certification on all remaining radar positions of operation (sectors) in an area of specialization	120 hours per sector, 120 days max; or 300 hours per sector, 300 days max (XIIIB)	OJT	Application and use of all topics and skills covered in previous phases of training under supervision of OJT Instructor(s) with live traffic

Source: FAA, 1988

Table 7. Enroute OJT curriculum track followed by group

Track	Phases[a]	MnATCTC		FAA Academy	
		N	%	*N*	%
Standard	V, VI, VII, VIII, IX, X, XI, XII, XIII	7	5.1		
A Track	V, VI, VII, **VIIA**, IX, X, XI, XII, XIII	11	8.1	5	3.2
B Track	V, VI, **VIIB**, **VIIIB**, IX, X, **XIB**, XII, **XIIIB**	32	23.5	66	42.0
8B Track:	V, VI, VII, **VIIIB**, IX, X, XI, XII, XIII	1	0.7	9	5.7
B Variation 1	V, VI, **VIIB**, **VIIIB**, IX, X, **XIB**, XII, XIII	4	2.9		
B Variation 2	V, VI, VII, VIII, IX, X, **XIB**, XII, XIII	1	0.7		
AB Track	V, VI, VII, **VIIIA**, IX, X, **XIB**, XII, **XIIIB**	7	5.1	10	6.4

Notes: [a]Variations in phases for each track shown in **boldface**.

completions, (c) training phase grades, (d) facility type and level, (e) facility disposition codes, and (f) facility types and levels at time of entry into field training and at time of data extraction. Possible training outcomes at the first assigned field facility included: (1) separation from the ATCS occupation (which may or may not involve termination from employment by the FAA); (2) attrition (without separation from the FG-2152 occupation or agency) from the first en route facility through facility or option change (e.g., switch to terminal or flight service); (3) still in developmental (training) status as a controller at the first en route facility; and (4) achieved Full Performance Level (FPL) in the ATCS occupation as of June 1995 at the first en route facility. Only outcomes at the first assigned facility are considered in this analysis for two reasons.

First, the training tracking system was originally designed to follow progress through OJT to the FPL at the first facility; the data for second or third assignments are both less reliable and less complete. Second, there are significant financial costs associated with moves from the first assigned facility prior to achievement of the FPL certification. Those costs may include, but are not limited to, expended training funds, time, permanent change of station (e.g., moving) costs, and personnel replacement costs. Therefore, improved outcomes at the first facility can lead to significant avoided costs for the FAA.

Performance ratings data collection

Survey administration. Facilities to which MnATCTC and FAA Academy graduates had been assigned were identified through CPMIS, as shown in Table 2. Working through the Air Traffic chain of command, supervisors and OJT instructors of MnATCTC and FAA Academy graduates were identified by the facilities. A mail-merge database, linking controller, supervisor, and OJT instructor, was developed on the basis of the data provided by facilities to support mailing a ratings package. The ratings package included a cover letter from the Director of Air Traffic Program Management (ATZ-1), an explanation of the project, instructions for rating, and the rating form. The cover letter was addressed to the rater by name, using the mail-merge database. The supervisor and OJT instructor forms indicated the name of the incumbent controller to be rated. Reminder cards were mailed to controllers, supervisors, and instructors about one month after the initial mailing.

Survey response rates. Performance evaluation survey response rates are presented in Table 8. OJT instructors for 53 (39.0%) of the MnATCTC graduates returned surveys, compared with 61 (38.9%) from OJT instructors of the FAA Academy graduates. The return rates for incumbent controllers from both groups were better, with 72.1% (98) of the MnATCTC graduates returning self-evaluation surveys compared with 68.1% (107) of the FAA Academy graduates. Supervisors for 64 of the 136 MnATCTC graduates (47.1%) and 95 of 157 FAA Academy graduates (60.5%) returned surveys. The instructor and incumbent return rates for each group were not statistically different. However, the return rate for supervisors of the FAA Academy group (60.5%) was significantly greater than the return rate for supervisors of the MnATCTC group (37.2%; $Z = -3.25, p \leq .001$).

Respondent characteristics. Demographic characteristics of the controllers that returned performance evaluation surveys are presented in Table 9. The majority of the MnATCTC graduates returning surveys were male (72.0%), as were the FAA Academy graduates (68.5%). All 12 of the minority MnATCTC graduates, and 20 of 21 minority FAA Academy graduates returned performance self-evaluation surveys.

Table 8. Performance evaluation survey return rates

	MnATCTC	FAA Academy
	OJT Instructors	
Mailed	136	157
Total returns	53	61
Return rate	39.0%	38.9%
	Controllers	
Mailed Controllers	136	157
Total returns	98	107
Return rate	72.1%	68.1%
	Supervisors	
Mailed Supervisors	136	157
Total returns	64	95
Return rate	47.1%	60.5%***

***$p \leq .001$

Table 9. Demographic characteristics of controller survey respondents

	MnATCTC			Academy		
Group	N_{Group}	$N_{respond}$	$\%_{Respond}$	N_{Group}	$N_{Respond}$	$\%_{Respond}$
			Gender			
Male	82	59	72.0%	130	89	68.5%
Female	54	39	72.2%	27	18	66.7%
Missing						
			Minority Status			
Non-minority	111	77	69.4%	136	87	64.0%
Minority	12	12	100.0%	21	20	95.2%
Missing	13	9	69.2%			

OJT instructors returning surveys had been controllers for an average of 13 years (SD = 6.7 years). These instructors had been at their current facility about 10 years (SD = 5.3 years) and had been in their current position as an instructor about 8 years on the average (SD = 5.2 years). They had been providing training to the developmental being rated an average of 12.9 months (SD = 24.4 months). There were no statistically significant differences on these measures between OJT instructors for MnATCTC and FAA Academy graduates.

The supervisors who provided performance evaluation ratings on MnATCTC and FAA Academy graduates for research purposes only in this study averaged 18.3 years (SD = 6.7) of experience in the ATCS occupation, with average of 12.5 years (SD = 7.5) in the current facility. These supervisors had an average of 5.2 years (SD = 3.8) of experience in their current positions as supervisors and had been supervising the rated CTI/ATCS or Academy graduate an average of 14.2 months (SD = 10.2). There were no significant differences between supervisors of MnATCTC and FAA Academy graduates on the times as controller, supervisor, or at the current facility. *However, supervisors of Academy graduates* reported significantly longer times supervising the rated incumbent (M = 15.9, SD = 10.7 months) than supervisors of MnATCTC graduates (M = 10.7, SD = 8.0 months; $t_{(1,199)} = 3.36$, $p \leq .001$). This is consistent with the previous finding that FAA Academy graduates had been at the first facility longer than the MnATCTC graduates.

Costs and benefits

Framework. Thompson (1980) identified the following major steps in cost-benefit analysis for program evaluation: (1) identify the decision-maker(s) who will use the results of the evaluation; (2) identify alternatives; (3) identify costs; (4) identify benefits; (5) value program effects in dollars; (6) discount those values for the effects of time; (7) take distributional effects into account, as appropriate; and (8) aggregate and interpret the valued effects. This program evaluation is intended to serve the decision-making requirements of FAA Air Traffic Services management. There are two alternatives considered *in the evaluation: training entry-level controllers at* (a) MnATCTC or (b) the FAA Academy. Costs, benefits, and the valuation of program effects in dollars are discussed below in detail. Opportunity costs, time-related discounts in the value of money, and distributional effects were not addressed in this initial cost-benefit analysis.

Costs. The agency incurs both direct and indirect costs in administering the MnATCTC and other programs under the CTI/ATCS charter. Direct costs to the agency include the Congressionally-mandated funds invested in the MnATCTC. Direct costs were obtained on the basis of public laws passed by the U.S. Congress (see Morrison, Fotohui, & Broach, 1996, for citations). Indirect costs include (a) program management staff time, (b) evaluation costs, and (c) other staff costs associated with supporting the programs. Indirect costs were estimated on the basis of an electronic mail survey in late 1994 of FAA program offices and managers. The survey requested estimates of the proportion of staff time and travel spent on the program by fiscal year. These indirect costs were then projected forward to provide estimates through the year 2003.

Benefits. Four major classes of direct, quantifiable benefits that could be expressed in terms of dollars were identified for the cost-benefit analysis. First, under the program structure described in the formative evaluation report (Morrison, Fotohui, & Broach, 1996), MnATCTC graduates took the written ATCS aptitude test battery but bypassed the screening program at the FAA Academy that was in place through March of 1992. MnATCTC graduates also bypassed the successor five-day computerized assessment of aptitude that was implemented in June 1992 to replace the former nine-week FAA Academy ATCS Nonradar Screen (Broach & Brecht-Clark, 1994). Therefore, the first benefit was avoided screening costs for MnATCTC graduates. Second, MnATCTC graduates bypassed the FAA Academy en route training program as implemented in June 1992, and were placed directly into field training. Therefore, the second monetary benefit to the agency was avoided training costs at the FAA Academy. Third, the performance verification (PV) function was delegated to the MnATCTC from June 1992 onwards; therefore, the third monetary benefit to the FAA was avoided costs for PV. Finally, as described in the field training measures, it was expected that MnATCTC graduates would take about the same time, or less, than FAA *Academy graduates to attain certification as FPL* en route controllers. Therefore, the fourth monetary benefit to the agency was savings associated with reduced times to FPL certification for MnATCTC graduates. Published figures were used to estimate costs of screening, FAA Academy training, and field training savings. Cumulative savings were projected forwards through the year 2003, as with costs.

Analyses

Employee diversity

The representation of women and minorities in the MnATCTC sample was compared with their representation in the FAA Academy sample. Fisher's Z-test was used to compare the proportions of women and minorities in the two evaluation samples, on the hypothesis that:

H_1: *Women and minorities will be equally represented in the MnATCTC and FAA Academy samples.*

Field training progress

The average number of days, hours of OJT, and ratings of performance in each phase of the field training curriculum were compared through a one-way analysis of variance between the two evaluation samples. However, results based on the raw numbers of days in phase, hours of OJT, and indicators of performance can be misleading due to differences in training programs between air route traffic control centers (ARTCCs), as well as curriculum differences noted in Table 7. For example, the historical average time to complete the same phase of en route training at one ARTCC may be very different from times at other centers. These differences may be attributable to variables such as traffic patterns, facility resources, and training loads (General Accounting Office, 1989a). As a result, the variability in the raw numbers of days in phase, hours of OJT, and indicators of performance may be more attributable to inter-facility differences rather than to between-group differences. To compensate, in some degree, for the influence of inter-facility differences on average times in training, the training measures for the evaluation samples were standardized relative to the historical means and standard deviations for each center to which subjects were assigned. The analysis of variance was then performed on these standardized training progress measures. The working hypothesis for analysis of the training measures was:

H_2: *The progress of MnATCTC graduates through field training will be the same as FAA Academy graduates, as indexed by standardized days spent, hours of OJT taken, and indicators of performance earned in each phase of en route field training.*

Attrition

Continued employment in the ATCS occupation, according to FAA Order 3330.30C (FAA, 1984), is contingent upon satisfactory progression to the full performance level. Failure to progress in training may be the basis for separation from the GS-2152 occupation. Alternatively, an individual not progressing satisfactorily in field training, as described under FAA Order 3120.24A (FAA, 1993), might be retained in the ATCS occupation, if, and only if, he or she has "shown potential for work at the full performance level in different facilities" (FAA, 1984, p. 3). In other words, two mutually exclusive attrition outcomes are possible at the first assigned facility. The trainee might be (a) separated from the ATCS occupation, or (b) offered the option to switch to a less demanding facility, such as a lower-level terminal facility or a Flight Service Station (FSS). Attrition, in either form, represents a significant economic cost to the agency. Attrition from ATCS training has been and continues to be a significant concern to the U.S. Congress as well (U.S. Congress, 1976; General Accounting Office, 1989b). Attrition rates for the two evaluation groups were compared, using Fisher's Z-test under the following hypothesis:

H_3: *MnATCTC and FAA Academy graduate attrition rates, defined as separations from the occupation and switches from the first assigned en route facility, will be equal.*

Performance ratings

First, the overall internal consistency of the ratings provided by instructors, incumbents, and supervisors was estimated for each major domain of the rating instrument as a measure of instrument internal reliability. Second, scale scores were computed by averaging valid responses across items comprising the scale. Third, scale scores were correlated by rating source to assess inter-rater reliability. Finally, domain scores for each group were compared by one-way analysis of variance to test the following hypothesis:

H_4: *The mean ratings of technical skill, technical knowledge, teamwork, and overall potential to succeed in the occupation given by supervisors and OJT instructors of MnATCTC and FAA Academy graduates, and by the graduates themselves, will be equal.*

As discussed previously, institutions participating in the CTI/ATCS program had raised concerns about how two factors might influence the subjective performance ratings. The first factor was acceptance in the facility, assessed by the incumbent's and other's perceptions. The second factor was the delay between graduation and hiring for MnATCTC graduates. Therefore, three additional analyses of variance were conducted, controlling separately and jointly for (a) the degree to which the incumbent felt accepted in the facility, (b) the degree to which the supervisor perceived the controller as being accepted in the facility, and (c) hiring delay.

Costs and benefits

As no formal statistical analyses are associated with cost-benefit comparisons, the research issues are framed as questions, rather than formal hypotheses. The first cost-benefit analysis focused on a comparison of the cost-per-hire between the MnATCTC and the FAA Academy programs. The research question addressed in this first analysis was:

Q_1: *At what point might the MnATCTC cost-per-hire be equal to or less than the cost-per-controller at the FAA Academy?*

The second analysis evaluated the ratio of accrued and projected costs, and benefits for the MnATCTC program to address the research question:

Q_2: *At what point are the benefits accruing from the MnATCTC program likely to balance or exceed the direct and indirect costs of the program, e.g., return one dollar or more in savings to the FAA for each dollar invested?*

RESULTS

Employee diversity

There were no significant differences by participating institution in the representation of minorities (Table 4). However, there were significantly more women in the MnATCTC sample (39.7%) than in the FAA Academy sample (17.2%; $Z = 3.67, p \leq .001$). As a result, the proportion of male non-minorities in the MnATCTC sample was significantly smaller (53.7%) than in the Academy graduates (67.2%; $Z = -2.55, p \leq .01$), apparently due to the larger proportion of non-minority females in the MnATCTC sample.

Field training progress

Descriptive statistics for the days, hours on-the-job training, and indicator of performance (IP) rating for each phase of en route training by program are presented in Table 10. Fewer days in phase and fewer hours of OJT represent better performance; conversely, a higher *IP* indicates better performance. On one hand, the one-way analyses of variance of raw training data by group indicated that MnATCTC graduates did significantly better than the comparison group of FAA Academy graduates on the following training measures: number of days and hours of OJT in PHASE VI; hours of OJT in PHASE VIII; days in PHASE IX, with and without adjustment for the number of sectors on which training was provided; days and hours of OJT in PHASE XI; and days in PHASE XIII. On the other hand, Academy graduates appeared to do better than MnATCTC graduates on the following training measures: PHASE VII days and hours of OJT; hours of OJT in PHASE IX, with and without adjusting for the number of sectors on which training was provided; and hours of OJT, adjusted for number of training sectors, in PHASE X and PHASE XI.

Analyses based on raw data, without consideration of inter-facility differences, are misleading, however. As noted above, previous research has found substantive differences on training progress measures between en route facilities not attributable to individual differences in the abilities of trainee controllers (Office of the Deputy Associate Administrator for Appraisal, 1989). A more realistic appraisal of the progress of MnATCTC and FAA Academy graduates is provided by an analysis of training measures standardized with respect to facility historical means and standard deviations for each phase. For example, the days in PHASE IX for a MnATCTC or FAA Academy graduate assigned to Minneapolis center would be standardized with respect to the historical mean and standard deviation of days in PHASE IX at that facility.

The results of the comparison of MnATCTC to FAA Academy graduates, using standardized training measures, are presented in Table 11. A negative standardized score for the days and hours OJT in phase indicate better performance than average. That is, a negative score indicates that a person took fewer days or hours of OJT than average. A positive standardized score for IP indicates a rating higher than average.

On one hand, graduates from the MnATCTC program performed statistically better than FAA Academy graduates on six standardized training measures. The graduates from the MnATCTC program required statistically fewer standardized days (0.02 standard deviations above facility average) in the

Table 10. En route days in phase, hours OJT in phase, and phase Indicator of Performance for MnATCTC and Academy graduates

Phase	Description	Measure	MnATCTC (*N*=136)			FAA Academy (*N*=157)			
			M	*SD*	*N*	*M*	*SD*	*N*	*F*
V	Assistant Controller	Days in Phase	40.21	7.42	136	41.47	29.87	157	0.23
		Hours OJT	227.47	40.75	136	225.20	54.89	157	0.16
		IP in Phase	4.08	0.85	106	4.24	0.77	148	2.69
VI	Assistant Controller Qual	Days in Phase	15.68	13.15	134	23.30	25.76	155	9.58**
		Hours OJT	41.43	36.41	134	49.72	25.31	155	5.17*
		IP in Phase	4.11	0.89	100	4.27	0.60	139	2.65
VII	Prelim Nonradar/Radar	Days in Phase	54.44	36.75	133	45.31	29.58	148	5.31*
		Hours OJT	247.88	82.22	133	212.97	106.02	148	9.13**
		IP in Phase	4.00	0.88	102	4.13	0.71	143	1.70
VIII	Initial Radar Associate Qual	Days in Phase	91.53	45.23	133	82.79	31.45	151	3.64
		Hours OJT	351.62	212.90	133	403.23	165.72	151	5.26*
		IP in Phase	3.66	1.18	103	3.90	0.95	147	3.31
IX	Initial Radar Associate Qual	Days in Phase	62.27	54.55	22	113.64	87.65	91	6.89**
		Hours OJT	210.70	62.28	123	170.33	57.52	144	30.27***
		IP in Phase	3.86	1.18	96	4.25	0.71	127	9.20**
		Sectors	2.00		121	2.00		139	
		Adj Days[a]	31.14	27.27	22	56.91	44.07	90	6.85**
		Adj Hours[a]	105.25	31.32	121	85.05	28.72	139	29.42***

(Table 10 continues)

(Table 10 continued)

Phase	Description	Measure	MnATCTC (N=136)			FAA Academy (N=157)			
			M	SD	N	M	SD	N	F
X	Final Radar Associate Qual	Days in Phase	149.96	78.06	85	166.62	135.56	117	1.10
		Hours OJT	202.93	80.49	85	194.44	69.09	117	0.65
		IP in Phase	4.23	0.81	71	4.12	0.65	107	0.88
		Sectors	5.09	1.17	80	6.13	1.33	106	31.08***
		Adj Days[a]	28.80	12.00	80	32.31	49.76	106	0.38
		Adj Hours[a]	40.95	16.24	80	32.87	13.21	106	14.00***
XI	Radar Controller Training	Days in Phase	56.21	22.10	76	72.53	25.80	139	21.68***
		Hours OJT	267.17	165.97	76	351.17	120.32	139	18.17***
		IP in Phase	4.11	1.11	64	4.02	1.01	131	0.29
XII	Initial Radar Position Qual	Days in Phase	155.45	67.87	47	142.11	78.38	133	1.08
		Hours OJT	232.26	72.30	47	203.30	64.47	133	6.57
		IP in Phase	4.02	0.99	41	4.17	0.77	124	0.94
		Sectors	2.00		46	2.00		132	
		Adj Days[a]	77.49	34.27	46	69.53	35.15	132	1.77
		Adj Hours[a]	115.77	36.47	46	101.57	32.34	132	6.15*
XIII	Final Radar Position Qual	Days in Phase	143.48	67.56	23	202.60	137.85	109	4.01*
		Hours OJT	199.65	86.22	23	248.77	119.31	110	3.51
		IP in Phase	4.48	0.68	21	4.30	0.65	104	1.29
		Sectors	2.61	0.66	23	4.01	09.1	105	48.36***
		Adj Days[a]	56.63	26.22	23	53.08	36.90	105	0.19
		Adj Hours[a]	78.49	31.85	23	65.42	31.65	107	0.00

Notes: [a]Adjusted for number of sectors trained on (Days or Hours divided by sectors) $^{*}p \leq .05$, $^{**}p \leq .01$, $^{***}p \leq .001$

Preliminary Nonradar/Radar Associate phase of field training (Phase VII) than FAA Academy graduates (0.14 standard deviations more than facility averages; $F(1, 279) = 5.68, p \leq .05$). MnATCTC graduates required statistically fewer standardized days of training in Phase IX (-0.85 standard deviation units fewer than average) than FAA Academy graduates (-0.13 standard deviation units fewer than average; $F(1,110) = 10.34, p \leq .01$). The same pattern held when the days in Phase IX were adjusted for the number of sectors on which controllers trained (MnATCTC = -0.84 standard deviations fewer than average, versus -0.13 standard deviations fewer than average for Academy graduates; $F(1,110) = 10.15, p \leq .01$). MnATCTC graduates also took fewer standardized days (0.02 standard deviations more than facility averages) in Final Radar Association Qualification training (Phase X) than FAA Academy graduates (0.50 standard deviations more than facility averages; $F(1, 200) = 8.60, p \leq .01$). Adjusting the days in Phase X training for the number of sectors on which controllers were trained did not change this pattern of results; MnATCTC required fewer adjusted days in training (just 0.11 standard deviations more than facility averages) than FAA Academy graduates (0.58 standard deviations more than facility averages; $F(1,184) = 5.84, p \leq .05$). The MnATCTC graduates also required statistically fewer standardized days in Radar Controller Training (Phase XI) than FAA Academy graduates. MnATCTC graduates required 0.51 standard deviations more than facility averages to complete Phase XI, while FAA Academy graduates required 0.71 standard deviations more than facility averages in the same training ($F(1,213) = 5.18, p \leq .05$).

On the other hand, FAA Academy graduates performed better than MnATCTC graduates on three standardized training measures. FAA Academy graduates earned higher standardized IPs, relative to facility averages, in Phase VI (0.33 standard deviations above facility averages) than did MnATCTC graduates (just 0.03 standard deviations above facility averages; $F(1,237) = 5.05, p \leq .05$). The FAA Academy graduates took fewer standardized days (0.24 standard deviations more than facility averages) in the Initial Radar Association Qualification training phase (Phase VIII) than MnATCTC graduates (0.50 standard deviations more than facility averages; $F(1, 282) = 5.22, p \leq .05$). The FAA Academy graduates required statistically fewer standardized hours of OJT in Phase X (0.44 standard deviations more than facility averages), adjusted for the number of sectors on which they trained, than did MnATCTC graduates (0.71 standard deviations above facility averages; $F(1, 184) = 4.29, p \leq .05$).

Training outcomes

Attrition

Outcomes at the first assigned field facility by school are presented in Table 12. Available information indicated that 10 (7.4%) MnATCTC graduates had attrited from the FG-2152 occupation as of June 1995. Just 6 (3.8%) FAA Academy graduates had attrited from their first assigned facility as of June 1995. The attrition rates were not significantly different ($Z = 0.91$, *ns*). Significantly more FAA Academy graduates switched options or facilities ($N = 7$; 4.5%), prior to reaching the full performance level (FPL) at their first assigned facility, than did MnATCTC graduates ($N = 1$, or 0.7%; $Z = 1.99$, $p \leq .05$). Statistically more MnATCTC graduates (75.0%) were still in training at their first assigned facility than FAA Academy graduates (22.9%; $Z = 8.91$, $p \leq .001$). Overall, significantly fewer MnATCTC had achieved FPL as of June 1995 ($N = 23$, or 16.9%) than FAA Academy graduates ($N = 108$, or 68.8%; $Z = -8.91, p \leq .001$).

Survival analysis

Survival analysis was also used to examine the proportions of FAA Academy and MnATCTC graduates remaining in the first assigned facility, that is, who had neither been separated from the occupation nor had switched facilities or options as of June 1995. Survival analysis is a useful technique for examining the interval between two events, such as enrollment in field training and attrition, when the second event (attrition) does not necessarily happen to everyone, and when subjects are observed for different periods of time (Norusis, 1990), as is the case in this evaluation. In survival analysis, the overall period of observation is subdivided into intervals. For this summative evaluation of the MnATCTC program, the period between enrollment on the job for each subject and June 30, 1995, or attrition from the first facility, was the observation period. The observation period was subdivided into one month intervals using the SPSS SURVIVAL procedure. For each one month interval, all subjects who were observed for at least that long were used to calculate the probability of attrition occurring in that interval by the SURVIVAL

Table 11. Standardized en route days in phase, hours OJT in phase, and phase indicator of Performance for MnATCTC and Academy graduates[a]

			MnATCTC			FAA Academy			
Phase	Description	Measure	*M*	*SD*	*N*	*M*	*SD*	*N*	*F*
V	Assistant Controller	Zdays Phase	0.31	0.57	136	0.34	1.51	157	0.05
		ZHours OJT	0.55	0.55	136	0.46	0.74	157	1.58
		ZIP Phase	0.02	0.90	106	0.01	0.88	148	0.02
VI	Assistant Controller Qual	ZDays Phase	0.03	0.96	134	-0.06	1.02	155	0.23
		ZHours OJT	-0.27	1.25	134	-0.23	0.74	155	0.10
		ZIP Phase	0.03	1.17	100	0.33	0.87	139	5.05*
VII	Prelim Nonradar/Radar	ZDays Phase	0.02	0.51	133	0.14	0.55	148	5.68*
		ZHours OJT	0.51	0.71	133	0.43	0.89	148	3.45
		ZIP Phase	-0.09	0.96	102	-0.09	0.85	143	0.01
VIII	Initial Radar Associate Qual	ZDays Phase	0.50	0.74	133	0.24	0.74	151	5.22*
		ZHours OJT	0.26	1.08	133	0.21	0.79	151	0.24
		ZIP Phase	0.02	0.98	103	0.16	0.85	147	1.46
IX	Initial Radar Associate Qual	ZDays Phase	-0.85	0.48	22	-0.13	1.02	91	10.34**
		ZHours OJT	0.64	0.80	123	0.51	0.86	144	1.71
		ZIP Phase	0.08	1.12	98	0.27	0.68	127	2.42
		Sectors	2.00		121	2.00		139	
		Adj ZDays[a]	-0.84	0.48	22	-0.13	1.03	90	10.15**
		Adj ZHours[a]	0.65	0.81	121	0.52	0.88	139	1.40

(Table 11 continues)

(Table 11 continued)

Phase	Description	Measure	MnATCTC *M*	MnATCTC *SD*	MnATCTC *N*	FAA Academy *M*	FAA Academy *SD*	FAA Academy *N*	*F*
X	Final Radar Associate Qual	ZDays Phase	0.02	78.06	1.12	0.50	1.17	117	8.60**
		ZHours OJT	0.47	0.90	85	0.49	0.75	117	0.40
		ZIP Phase	0.21	0.88	71	0.07	0.69	107	1.50
		Sectors	5.09	1.17	80	6.13	1.33	106	
		Adj ZDays[a]	0.11	0.80	80	0.58	1.58	106	5.84*
		Adj ZHours[a]	0.70	0.94	80	0.44	0.77	106	4.29*
XI	Radar Controller Training	Zdays Phase	0.51	0.76	76	0.71	0.52	139	5.18*
		ZHours OJT	1.14	0.99	76	1.01	0.64	139	1.29
		ZIP Phase	0.03	1.07	64	0.03	0.99	131	0.00
XII	Initial Radar Position Qual	ZDays Phase	0.64	1.05	47	0.55	1.27	133	0.18
		ZHours OJT	0.71	0.79	47	0.56	0.91	133	0.95
		ZIP Phase	0.04	0.93	41	0.23	0.67	124	2.00
		Sectors	2.00		46	2.00		132	
		Adj ZDays[a]	0.66	1.09	46	0.54	1.21	132	0.35
		Adj ZHours[a]	0.71	0.80	46	0.57	0.91	132	0.95
XIII	Final Radar Position Qual	Zdays Phase	-0.19	0.69	23	0.16	0.97	109	2.71
		ZHours OJT	0.48	1.01	23	0.44	0.96	110	0.05
		ZIP Phase	0.25	0.65	21	0.14	0.63	104	0.58
		Sectors	2.61	0.66	23	4.01	0.91	105	
		Adj ZDays[a]	0.66	0.93	23	0.59	1.00	105	0.09
		Adj ZHours[a]	1.21	0.96	23	0.84	0.90	107	3.18

Notes: [a]Adjusted for number of sectors trained on (Days or Hours divided by sectors) *$p \leq .05$, **$p \leq .01$, ***$p \leq .001$

Table 12. Outcomes at first assigned facility

Outcome	MnATCTC	FAA Academy	Total
Attrited from 2152	10 (7.4%)	6 (3.8%)	16 (5.5%)
Moved from 1st fac	1 (0.7%)	7 (4.5%)	8 (2.7%)
Still developmental	102 (75.0%)	36 (22.9%)	138 (47.1%)
Made FPL	23 (16.9%)	108 (68.8%)	131 (44.7%)
Total	136	157	293

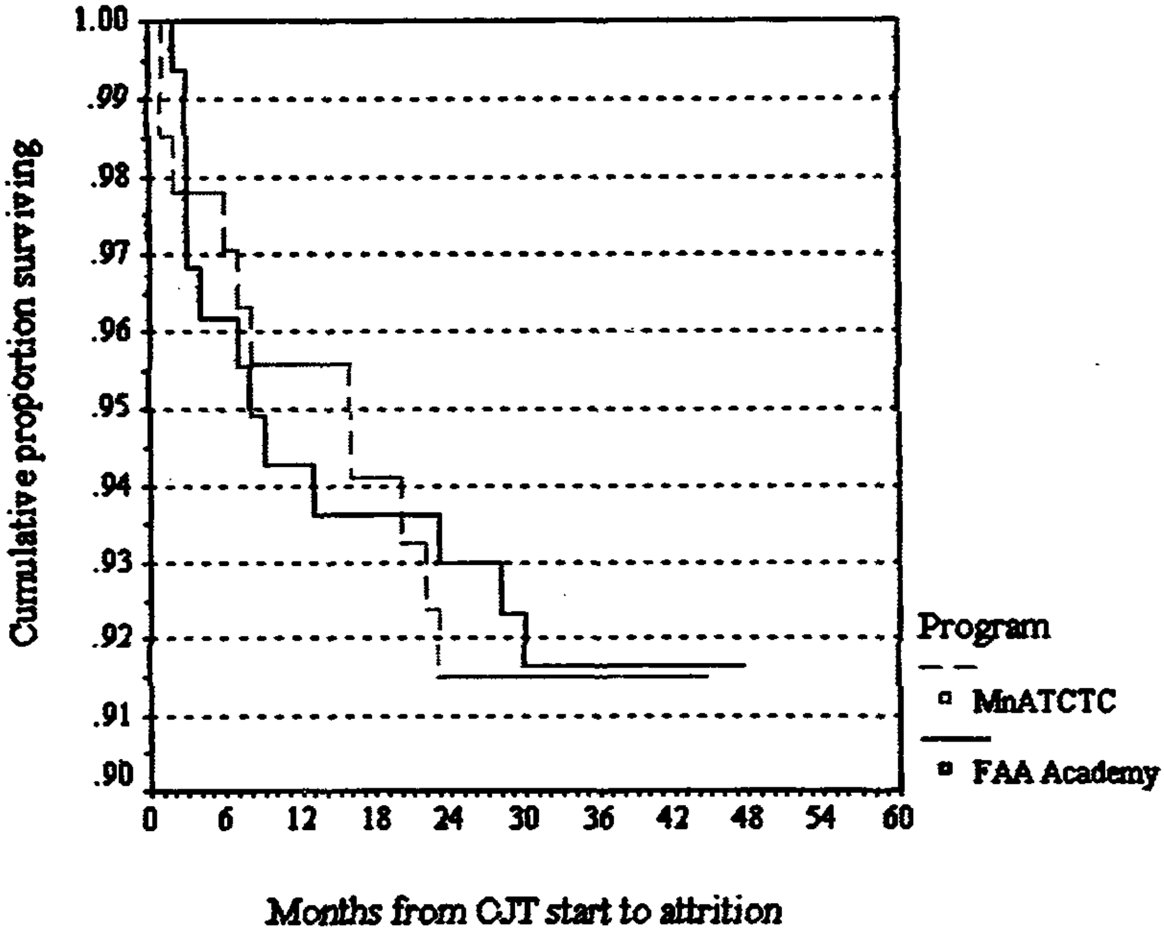

Figure 1. MnATCTC and FAA Academy attrition/survival analysis

procedure. The result is an estimate, for each group, of the cumulative proportion of graduates remaining at the first assigned facility at one, two, three and so on months after enrollment in field training. The SPSS SURVIVAL procedure uses the Wilcoxon or Gehan statistic to test the hypothesis that the survival distributions are the same for MnATCTC and FAA Academy samples (Norusis, 1990, p. 244).

The results of the survival analysis are presented in Figure 1. More than 90% of both FAA Academy and MnATCTC graduates had survived at the first assigned facility, as would be expected from the simple rate of attrition analysis reported above. The survival distributions were not statistically different (Wilcoxon = 2.987, $df = 1$, $p = .084$, *ns*) for the two groups. This analysis suggested that, after taking into account the different lengths of time the groups had been at their first assigned facilities, there were no statistically significant differences in the proportions of MnATCTC and FAA Academy graduates that would be expected to remain (e.g., neither be separated from the occupation nor switch option or facility) at the first assigned facility over time.

FPL Certification

Time to FPL

Just 23 (16.9%) MnATCTC graduates were certified as FPLs at their first assigned field facility as of June 1995. In contrast, 68.8% of the FAA Academy graduates had attained FPL certification by June 1995. This is consistent with the greater time at the first assigned facility for FAA Academy graduates: with longer times in the facility, a larger proportion of FAA Academy graduates would be expected to have completed the field training sequence. The average number of years to certification, as shown in Table 13, was not significantly different between the two programs. MnATCTC graduates required about 2.82 ($SD = 0.59$) years to certify, in comparison to 3.18 ($SD = 0.53$) years for FAA Academy graduates ($F(1,130) = 0.00$, *ns*). Times to FPL were also standardized, with respect to historical facility averages, and compared. Both groups required slightly more time to FPL than historical averages (0.34 standard deviations more than average for MnATCTC graduates, compared with 0.55 standard deviations more than average for FAA Academy graduates). However, the standardized times to FPL were not statistically different for the two groups ($F(1, 130) = 0.22$, *ns*).

Accession to FPL

Survival analysis was used to evaluate, from a different perspective, the proportion of surviving graduates by program and option still in training (developmental status), as of June 1995, relative to their enrollment date. The terminating event in this analysis was making FPL. The analysis provides comparative data about when program graduates made FPL, taking into account the different lengths of observation. The results of this second survival analysis for the Academy and MnATCTC graduates who did not attrite in the enroute option are presented in Figure 2. Taking into account the differing amounts of time in the field, the survival distributions for the two groups are not statistically different (Wilcoxon = 0.039, $df = 1$, *ns*). This analysis suggests that, with time, MnATCTC graduates can be expected to achieve FPL certification at about the same time and at about the same rates as FAA Academy graduates.

Performance ratings

Reliability

Scale scores for 4 domains were computed from the returned surveys: TEAMWORK (15 items); degree of acceptance (ACCEPTANCE) in the facility (5 items); TECHNICAL SKILL (11 items); and TECHNICAL KNOWLEDGE (11 items). Scale scores were computed as the average of valid responses to the items comprising a scale. A scale score of 1 indicated a low degree, 2 an acceptable degree, 3 a higher degree, and 4 the highest degree of ACCEPTANCE, TEAMWORK, TECHNICAL SKILL, or TECHNICAL KNOWLEDGE. Estimates of Cronbach's alpha (α), a measure of internal consistency, for the

Table 13. Years and standardized years to full performance level (FPL) in the en route option

	MnATCTC			FAA Academy			
	M	*SD*	*N*	*M*	*SD*	*N*	*F*
Years to FPL	2.82	0.59	23	3.18	0.53	108	0.00
ZYears to FPL[a]	0.34	0.87	23	0.55	0.70	108	0.22

Notes: [a]Years to FPL standardized with respect to historical means and standard deviations for facility type and level to which person was assigned

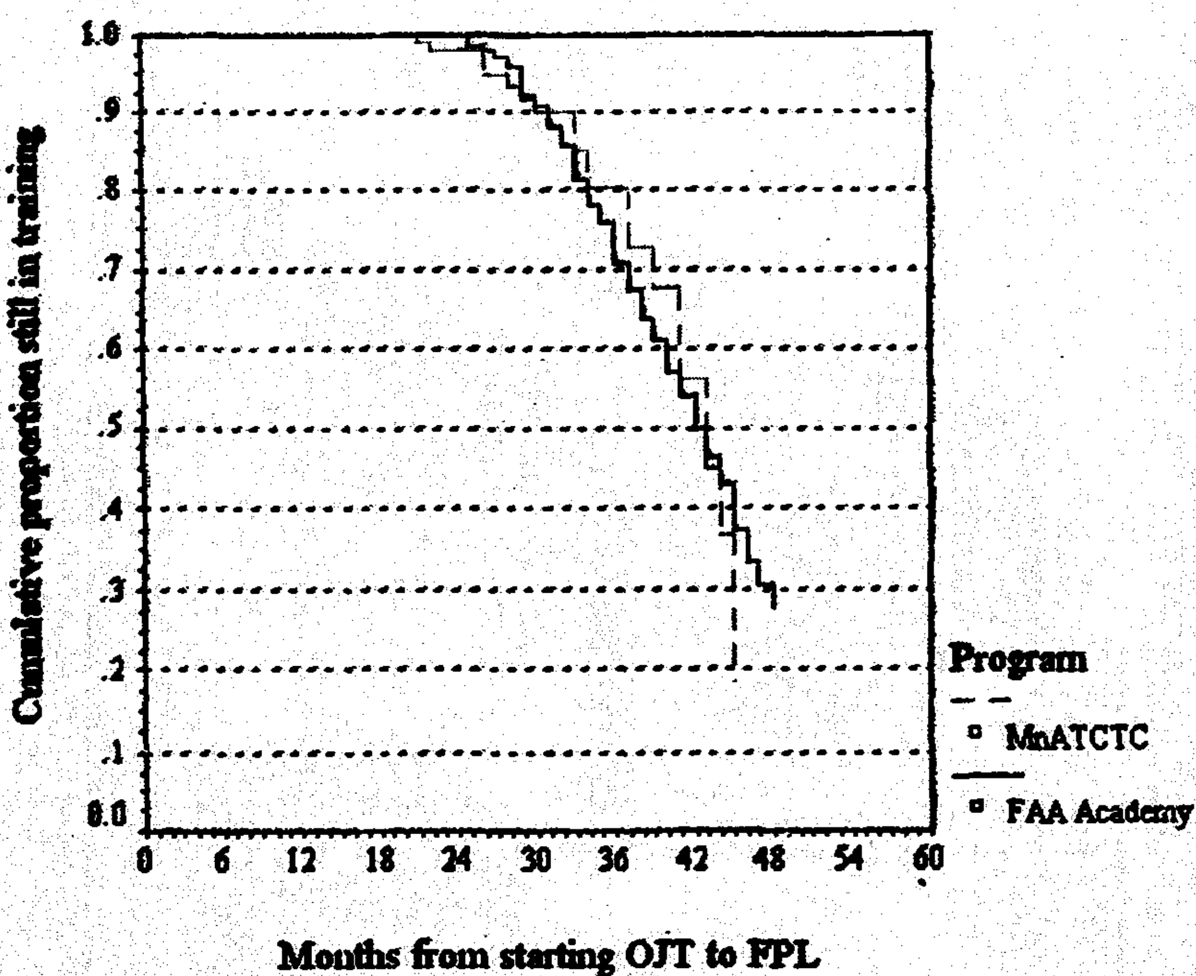

Figure 2. MnATCTC and FAA Academy accession to FPL over time analysis

TEAMWORK scale were .94 for OJT instructors, .94 for controllers, and .96 for supervisors. Internal consistency estimates for the 5-item ACCEPTANCE scale were lower and barely acceptable, ranging from .42 for supervisors to .59 for controllers. The TECHNICAL SKILL and TECHNICAL KNOWLEDGE scale internal consistency estimates were above .90 for all three rating sources.

The degree of inter-rater reliability on the scales was assessed by computing correlations between instructors, controllers, and supervisors. Inter-rater correlations of instructors with controller and supervisor ratings were generally low for TEAMWORK, TECHNICAL SKILL, TECHNICAL KNOWLEDGE, and ratings of potential to succeed (POTENTIAL), as shown in Table 14. Correlations of controller with supervisor ratings were moderate for TEAMWORK, TECHNICAL SKILL, and TECHNICAL KNOWLEDGE. The correlation between controller self- and supervisory evaluation of POTENTIAL to succeed in the occupation was good ($r = .72, p \leq .001$). Overall, the pattern of results indicated a relatively low degree of agreement between raters by source. Therefore, the ratings data were analyzed by rating source.

OJT Instructor

The analysis of OJT instructor ratings by performance domain by school is presented in Table 15. Instructor ratings were returned for 53 MnATCTC and 61 FAA Academy graduates. The instructor evaluation of the degree to which the person rated was accepted (ACCEPTANCE) in the facility did not differ by school ($F(1,113) = 1.06$, *ns*). That is, OJT instructors perceived MnATCTC graduates as being as well accepted in the facility as FAA Academy graduates. The mean instructor ratings on TEAMWORK for MnATCTC and FAA Academy graduates were not statistically different ($F(1,113) = 0.65$, *ns*). In other words, OJT instructors perceived the teamwork of MnATCTC graduates as being about the same as that

Table 14. Performance ratings dimension inter-rater correlations by rating source

					Rating Dimension														
					Teamwork			Accepted			Technical Skill			Tech Knowledge			Success Potential		
Dimension	Rater	*M*	*SD*	*N*	OJTI	ATCS	SUPV	OJTI	ATCS	SUPV	OJTI	ATCS	SUPV	OJTI	ATCS	SUPV	OJTI	ATCS	SUPV
TEAMWORK	OJT-Inst	2.35	0.74	114	*94*														
	Controller	2.56	0.64	229	39**	*96*													
	Supervisor	2.33	0.67	159	35**	65**	*96*												
ACCEPTANCE	OJT-Inst	2.76	0.64	114	54**	26**	12	*58*											
	Controller	2.73	0.64	229	09	45**	44**	15	*69*										
	Supervisor	2.78	0.62	158	21*	47**	46**	11	57**	*66*									
SKILL	OJT-Inst	2.00	0.67	114	79**	35**	37**	46**	16	18	*96*								
	Controller	2.17	0.67	226	37**	71**	51**	27**	29**	28**	41**	*97*							
	Supervisor	2.00	0.61	156	43**	49**	79**	26**	27**	31**	46**	64**	*97*						
KNOWLEDGE	OJT-Inst	2.44	0.63	114	68**	36**	34**	54**	18*	25*	73**	31**	41**	*91*					
	Controller	2.53	0.62	226	29**	64**	41**	18*	33*	37**	36**	70**	44**	33**	*95*				
	Supervisor	2.41	0.62	158	23*	46**	69**	06	37**	37**	30**	50**	74**	28**	63**	*96*			
POTENTIAL	OJT-Inst	82.93	17.49	112	69**	51**	41**	41**	31**	46**	69**	40**	45**	63**	32**	28**			
	Controller	87.98	15.92	230	49**	70**	49**	29**	34**	26**	51**	62**	47**	44**	58**	46**	49**		
	Supervisor	83.67	17.05	157	50**	49**	65**	23*	30**	34**	51**	53**	67**	43**	36**	57**	52**	72**	

Note: Decimals omitted for correlations. *$p \leq .05$, **$p \leq .01$, ***$p \leq .001$

of FAA Academy graduates. However, OJT instructors rated the TECHNICAL SKILL of MnATCTC graduates as being lower than that of FAA Academy graduates ($F(1,113) = 7.17, p \leq .01$). These same instructors also evaluated the TECHNICAL KNOWLEDGE of MnATCTC graduates as being lower than that of FAA Academy graduates ($F(1,113) = 6.33, p \leq .05$). However, the overall POTENTIAL of MnATCTC graduates to succeed in the occupation ($M = 79.65, SD = 18.74$ on a 40 to 100 scale) was not rated significantly lower than that of FAA Academy graduates ($M = 85.77, SD = 15.95$; $F(1,111) = 3.48$, *ns*).

Controller

Overall, the mean scale scores for FAA Academy graduates across all five rating dimensions were statistically higher than the mean scale scores for MnATCTC controllers when computed on self-ratings (Table 16). The average self-rating on TEAMWORK for FAA Academy graduates was 2.68 (on a 1 to 5 scale), compared with a mean of 2.42 for MnATCTC self-evaluations of TEAMWORK ($F(1,228) = 9.71, p \leq .01$). FAA Academy graduates felt themselves to be better accepted at the facility (ACCEPTANCE: $M = 2.85, SD = 0.56$) than did MnATCTC graduates ($M = 2.60, SD = 0.69$; $F(1,228) = 9.18, p \leq .01$). FAA Academy graduates also rated their TECHNICAL SKILL more highly ($M = 2.33, SD = 0.55$) than did MnATCTC graduates ($M = 1.98, SD = 0.75$; $F(1,225) = 16.72, p \leq .001$). Similarly, FAA Academy graduates rated their TECHNICAL KNOWLEDGE of air traffic control more highly ($M = 2.69, SD = 0.50$ on a 1 to 5 scale) than did MnATCTC graduates ($M = 2.36, SD = 0.70$; $F(1,227) = 16.48, p \leq .001$). Finally, FAA Academy graduates rated themselves as having greater POTENTIAL to succeed in the occupation ($M = 91.45, SD = 11.73$ on a 40-100 scale) than did the MnATCTC graduates ($M = 84.22, SD = 18.77$; $F(1,229) = 12.44, p \leq .001$).

Table 15. OJT Instructor (OJT-I) ratings on performance dimensions

	MnATCTC			FAA Academy			
	M	*SD*	*N*	*M*	*SD*	*N*	*F*
TEAMWORK	2.29	0.76	53	2.40	0.72	61	0.65
ACCEPTANCE	2.70	0.65	53	2.81	0.50	61	1.06
TECHNICAL SKILL	1.83	0.65	53	2.16	0.66	61	7.17**
TECHNICAL KNOWLEDGE	2.28	0.66	53	2.57	0.58	61	6.33*
POTENTIAL	79.65	18.74	52	85.77	15.95	60	3.48

*$p \leq .05$, **$p \leq .01$, ***$p \leq .001$

Table 16. Controller self-ratings on performance dimensions

	MnATCTC			FAA Academy			
	M	*SD*	*N*	*M*	*SD*	*N*	*F*
TEAMWORK	2.42	0.75	109	2.68	0.51	120	9.71**
ACCEPTANCE	2.60	0.69	109	2.85	0.56	120	9.18**
TECHNICAL SKILL	1.98	0.75	106	2.33	0.55	120	16.72***
TECHNICAL KNOWLEDGE	2.36	0.70	108	2.69	0.50	120	16.48***
POTENTIAL	84.22	18.77	111	91.45	11.73	119	12.44***

*$p \leq .05$, **$p \leq .01$, ***$p \leq .001$

Supervisor

The supervisor ratings (Table 17) followed a similar pattern as the controller self-ratings: the mean ratings assigned by supervisors for FAA Academy graduates were statistically greater than the mean ratings for MnATCTC graduates across all five rating dimensions. The mean scale score of supervisory ratings on TEAMWORK for FAA Academy graduates ($M = 2.48$, $SD = 0.62$ on a 1 to 5 scale) were statistically greater than those for MnATCTC graduates ($M = 2.11$, $SD = 0.69$; $F(1,158) = 12.93, p \leq .001$). Supervisors perceived FAA Academy graduates as being better accepted at the facility (ACCEPTANCE: $M = 2.88$, $SD = 0.62$) than MnATCTC graduates ($M = 2.65$, $SD = 0.61$, $F(1,157) = 5.22$, $p \leq .05$). The TECHNICAL SKILL of FAA Academy graduates ($M = 2.09$, $SD = 0.58$) was rated more highly by supervisors than was that of MnATCTC graduates ($M = 1.86$, $SD = 0.63$; $F(1,155) = 5.19$, $p \leq .05$). The mean TECHNICAL KNOWLEDGE ratings by supervisors followed the same pattern, with FAA Academy graduates being rated more highly, on average ($M = 2.56$, $SD = 0.55$) than MnATCTC graduates ($M = 2.20$, $SD = 0.67$; $F(1,157) = 13.16$, $p \leq .001$). Finally, supervisors saw more POTENTIAL to succeed in the ATCS occupation, on average, in FAA Academy graduates ($M = 86.08$, $SD = 15.65$, on a 40-100 scale) than in MnATCTC graduates ($M = 80.17$, $SD = 18.47$; $F(1,156) = 4.65, p \leq .05$).

Influence of degree of acceptance and delay on supervisor ratings

As noted previously, institutions participating in the CTI/ATCS program had raised concerns about the potential influence of the degree to which a program graduate was accepted at the local facility on supervisory ratings of skill, knowledge, and performance. Concerns about the impact of substantial hiring delays on those ratings, due to skill and knowledge decay over time, were also expressed by institutional representatives. Therefore, supplemental analyses of covariance were conducted, in which supervisor ratings were analyzed after taking into account the effects of acceptance and hiring delay as covariates. For these analyses, the degree of ACCEPTANCE in the facility was taken from the controller's perspective. Procedurally, the controller's perceived degree of ACCEPTANCE in the facility and the time between graduation and hiring were processed as covariates before the main effect of program (MnATCTC versus FAA Academy) was analyzed using the SPSS ANOVA command. Instructor evaluations were not addressed in this analysis, as the concern expressed by institutional representatives focused on supervisors.

Degree of acceptance. The results of the analysis of supervisor ratings across performance dimensions, controlling for the incumbent specialist's perceived degree of ACCEPTANCE in the facility, are presented in Table 18. The first dimension considered was TEAMWORK. The total variability in the TEAMWORK rating is subdivided in the analysis into four components in three steps. First, the amount of the variability attributable to controllers' ratings of ACCEPTANCE in the facility was computed:

Total variability = variability due to ACCEPTANCE + remaining variability.

A test was computed to determine if the amount of variability explained by degree of ACCEPTANCE (the covariate) was statistically significant. Second, the

Table 17. Supervisor ratings on performance dimensions

	MnATCTC			FAA Academy			
	M	*SD*	*N*	*M*	*SD*	*N*	*F*
TEAMWORK	2.11	0.69	64	2.48	0.62	95	12.93***
ACCEPTANCE	2.65	0.61	63	2.88	0.62	95	5.22*
TECHNICAL SKILL	1.86	0.63	61	2.09	0.58	95	5.19*
TECHNICAL KNOWLEDGE	2.20	0.67	63	2.56	0.55	95	13.16***
POTENTIAL	80.17	18.47	64	86.08	15.65	93	4.65*

*$p \leq .05$, **$p \leq .01$, ***$p \leq .001$

Table 18. Supervisor ratings on performance dimensions, controlling for controller's perceived degree of ACCEPTANCE in the facility

	Program						
Dimension	MnATCTC	FAA Academy	Element	Label	Sum of Squares	*df*	*F*
TEAMWORK	2.08	2.48	Covariate	ACCEPTANCE	14.47	1	43.11***
			Main effect	PROGRAM	2.98	1	8.86**
			Model		17.49	2	25.99***
			Residual		52.03	155	
			Total		69.48	157	
TECHNICAL SKILL	1.84	2.09	Covariate	ACCEPTANCE	2.70	1	7.85**
			Main effect	PROGRAM	1.30	1	3.79
			Model		4.00	2	5.82**
			Residual		52.26	152	
			Total		52.56	154	
KNOWLEDGE	2.19	2.56	Covariate	ACCEPTANCE	7.63	1	23.28***
			Main effect	PROGRAM	2.90	1	8.84**
			Model		10.53	2	16.06***
			Residual		50.49	154	
			Total		61.02	156	
Potential	79.94	86.08	Covariate	ACCEPTANCE	3811.96	1	14.31***
			Main effect	PROGRAM	661.63	1	2.48
			Model		4473.59	2	8.40***
			Residual		40748.00	153	
			Total		45221.60	155	

*$p \leq .05$, **$p \leq .01$, ***$p \leq .001$

amount of remaining variability explained by or attributable to the differences between programs, as the main effect, was computed:

Total variability = variability due to ACCEPTANCE + variability due to PROGRAM + leftover variability.

A test is computed to determine if the amount of variability explained by PROGRAM, as the main effect, was statistically significant. Finally, the amount of variability in TEAMWORK ratings attributable to the joint effects of ACCEPTANCE and PROGRAM, as the overall model for the relationships between TEAMWORK ratings, ACCEPTANCE, and PROGRAM, was computed:

Total variability = variability due to ACCEPTANCE + variability due to PROGRAM + variability due to both + residual variability.

A final test was computed to determine if the amount of variability explained jointly by acceptance and program was statistically significant.

The mean supervisor's rating of TEAMWORK for MnATCTC graduates was 2.08, compared with 2.48 for FAA Academy graduates. The covariate in the analysis was each controller's scale score for the degree to which he or she felt accepted at the facility (ACCEPTANCE). The covariate accounted for a statistically significant portion of the overall variability in the supervisory ratings of TEAMWORK ($F = 43.11, p \leq .001$). PROGRAM also accounted for a statistically significant portion of the overall variability in TEAMWORK supervisory ratings ($F = 8.86, p \leq .01$). The degree of ACCEPTANCE and PROGRAM also jointly accounted for a statistically significant portion of variance in supervisory ratings of TEAMWORK ($F = 25.99, p \leq .001$). This pattern of results suggests that, even after accounting for the effects of how well the controller felt accepted at the facility, the MnATCTC graduates were still rated lower on teamwork than FAA Academy graduates.

Analysis of the supervisor's TECHNICAL SKILL ratings presents a different picture. The mean rating for MnATCTC graduates was 1.84, compared with 2.09 for FAA Academy graduates on the TECHNICAL SKILL dimension. The degree to which the incumbent controller felt accepted at the facility (ACCEPTANCE) accounted for a statistically significant portion of the overall variability in supervisory ratings of TECHNICAL SKILL ($F = 7.85, p \leq .01$). However, PROGRAM (MnATCTC or FAA Academy) did not significantly affect supervisory ratings of TECHNICAL SKILL. This analysis suggests that differences in the mean ratings of the technical skill of MnATCTC and FAA Academy graduates may be attributable to differences in the degree to wh h controllers were accepted at the facility rather than to where they were initially trained.

Analysis of the supervisory ratings of TECHNICAL KNOWLEDGE present a pattern similar to that of the TEAMWORK ratings. The mean rating of MnATCTC graduate TECHNICAL KNOWLEDGE by supervisors was 2.19, compared with 2.56 for FAA Academy graduates on a 1 (low) to 5 (high) point scale. The degree of ACCEPTANCE, from the controller's perspective, accounted for a statistically significant portion on the variance in supervisory ratings of TECHNICAL KNOWLEDGE ($F = 23.28, p \leq .001$). However, even after accounting for the effects of ACCEPTANCE, the program at which the incumbent was initially trained (PROGRAM) still accounted for a statistically significant portion of the variance in supervisory ratings of TECHNICAL KNOWLEDGE ($F = 8.84, p \leq .01$). This pattern suggests that differences in ratings of TECHNICAL KNOWLEDGE for MnATCTC and FAA Academy graduates cannot be explained away merely as a consequence of MnATCTC graduates being less well accepted at the facility. Rather, the difference in supervisory ratings may reflect real differences in the air traffic control technical knowledge of the two groups.

The pattern of results for the analysis of supervisory ratings of incumbent POTENTIAL to succeed is similar to that of ratings of TECHNICAL SKILL. The mean rating of MnATCTC graduate POTENTIAL to succeed was 79.94, compared with 86.08 for FAA Academy graduates. The degree to which controllers felt accepted at the facility (ACCEPTANCE) accounted for a statistically significant portion of the overall variability in ratings of POTENTIAL to succeed ($F = 14.31, p \leq .001$). However, PROGRAM (MnATCTC or FAA Academy) did not account for any significant variance ($F = 2.48$, *ns*). This analysis suggests that differences in the supervisory ratings of POTENTIAL to succeed might have been influenced by the degree to which the new controllers were accepted at the facility, but not by the program from which the controller graduated. In other words, persons perceiving themselves as less well accepted at the facility were also seen as having less potential to succeed in the ATCS occupation by their supervisors, regardless of the person's hiring source (FAA Academy or MnATCTC).

Hiring delay. The second covariate analyzed was the delay between graduation and hiring. FAA Academy graduates experienced very little delay between Academy graduation and starting OJT at their first facility ($M = 0.23$ months). MnATCTC graduates, in contrast, experienced average delays of 6 months between graduation in Minnesota and starting OJT ($M = 6.02$ months, $SD = 3.07$). It was hypothesized by CTI/ATCS representatives that the hiring DELAY would lead to a time-based degradation of skills and knowledge. As a consequence, MnATCTC graduates might receive lower ratings than FAA Academy graduates who had not experienced those delays and attendant knowledge and skill losses. As with the degree of ACCEPTANCE, analysis of covariance was used to explore the degree to which hiring delays influenced supervisory ratings of TEAMWORK, TECHNICAL SKILL, TECHNICAL KNOWLEDGE, and POTENTIAL to succeed in the ATCS occupation.

The results of this analysis are presented in Table 19. Hiring DELAY accounted for a statistically significant portion of the overall variability in supervisory ratings of TEAMWORK ($F = 5.30, p \leq .05$). However, PROGRAM (MnATCTC or FAA Academy) still accounted for a statistically significant portion of variability in TEAMWORK ratings ($F = 9.89, p \leq .01$), even after accounting for the effects of hiring delays. This pattern of results suggests that differences in the mean supervisory ratings of TEAMWORK for MnATCTC and FAA Academy graduates were not merely the result of delays in hiring but may have reflected real differences between the groups.

In contrast, hiring DELAY was not a statistically significant factor in explaining the variability of supervisor's ratings of TECHNICAL SKILL ($F = 2.00$, *ns*). Differences in the mean ratings were attributable only to the PROGRAM in which the controller was initially trained ($F = 4.19, p \leq .05$). This analysis suggests that hiring delays had no effect on the mean ratings of TECHNICAL SKILL for the two groups.

Supervisory ratings of TECHNICAL KNOWLEDGE followed the same pattern as TEAMWORK, with both hiring delay and PROGRAM accounting for statistically significant portions of the overall variability in TECHNICAL KNOWLEDGE supervisory ratings. This pattern of results suggested that differences in the mean ratings of TECHNICAL KNOWLEDGE for MnATCTC and FAA Academy graduates were not merely the result of delays in hiring, but may have reflected real differences between the groups.

Finally, supervisory ratings of POTENTIAL to succeed in the occupation for the two groups followed the same pattern as the TECHNICAL SKILL ratings. Hiring DELAY was not a significant factor in explaining the variability in ratings of POTENTIAL to succeed for the two groups ($F = 0.02$, *ns*), while PROGRAM was ($F = 15.94, p \leq .001$). In other words, differences in supervisory ratings of POTENTIAL to succeed in the ATCS occupation could not be attributed to the delay in hiring MnATCTC graduates.

Joint effects of acceptance and hiring delay. The last analysis of covariance considered the joint effects of the degree to which a controller felt accepted at the facility (ACCEPTANCE), and the DELAY in hiring experienced, on supervisory ratings of TEAMWORK, TECHNICAL SKILL, TECHNICAL KNOWLEDGE, and POTENTIAL to succeed in the ATCS occupation. The results of this covariate analysis for TEAMWORK supervisory ratings are presented in Table 20. ACCEPTANCE was a significant factor in explaining the overall variability in supervisor ratings of TEAMWORK ($F = 43.04, p \leq .001$). Hiring DELAY was also a significant factor ($F = 4.33$, $p \leq .05$), as was the combined effects of the two covariates ($F = 23.69, p \leq .01$). However, even after accounting for the joint effects of ACCEPTANCE and hiring DELAY, PROGRAM still had a statistically significant main effect on supervisor ratings of TEAMWORK ($F = 5.27, p \leq .05$). These results suggest that differences in TEAMWORK ratings between MnATCTC and FAA Academy graduates cannot be explained away as the effects of not being accepted at the facility and long delays in hiring MnATCTC graduates but may have reflected real differences in the teamwork of MnATCTC compared with FAA Academy graduates.

The analysis of supervisory ratings of TECHNICAL SKILL, taking into account the joint effects of acceptance and hiring delay, leads to a different result (Table 21). The acceptance covariate was a significant factor in the overall variability of supervisor ratings of TECHNICAL SKILL ($F = 7.83, p \leq .01$) but not hiring delay ($F = 1.59$, *ns*). After accounting for the effects of the degree to which the controller felt accepted at the facility, PROGRAM (MnATCTC or FAA Academy) accounted for a statistically significant portion of the overall variability in ratings of TECHNICAL SKILL ($F = 4.71, p \leq .01$). These results suggested that the lower ratings on TECHNICAL SKILL for the MnATCTC graduates, compared with FAA Academy graduates, could not be explained away by

Table 19. Supervisor ratings on performance dimensions, controlling for DELAY between graduation and reporting to facility

Dimension	Program: MnATCTC ($N = 63$)	Program: FAA Academy ($N = 95$)	Element	Label	Sum of Squares	*df*	*F*
TEAMWORK	2.08	2.48	Covariate	Hiring DELAY	2.21	1	5.30*
			Main effect	PROGRAM	4.12	1	9.89**
			Model		6.32	2	7.59***
			Residual		64.95	156	
			Total		71.27	158	
TECHNICAL SKILL	1.84	2.09	Covariate	Hiring DELAY	0.72	1	2.00
			Main effect	PROGRAM	1.51	1	4.19*
			Model		2.23	2	3.09*
			Residual		55.22	153	
			Total		57.45	155	
KNOWLEDGE	2.19	2.56	Covariate	Hiring DELAY	2.09	1	5.80*
			Main effect	PROGRAM	3.30	1	9.17**
			Model		5.39	2	7.49***
			Residual		55.79	155	
			Total		61.18	157	
Potential	79.94	86.08	Covariate	Hiring DELAY	5.78	1	0.02
			Main effect	PROGRAM	4253.40	1	15.94***
			Model		4259.18	2	7.98***
			Residual		41091.60	154	
			Total		43350.80	156	

$^{*}p \leq .05$, $^{**}p \leq .01$, $^{***}p \leq .001$

Table 20. Supervisor ratings of TEAMWORK, controlling for ATCS's perceived degree of ACCEPTANCE in the facility and DELAY between graduation and hiring

	Program						
	MnATCTC	FAA Academy					
Dimension	($N = 63$)	($N = 95$)	Element	Label	Sum of Squares	*df*	*F*
Teamwork	2.08	2.48	Covariate	ACCEPTANCE	14.47	1	43.04***
			Covariate	Hiring DELAY	1.46	1	4.33*
			Combined		15.93	2	23.69***
			Main effect	PROGRAM	1.77	1	5.27*
			Model		17.70	3	17.55***
			Residual		51.78	154	
			Total		69.48	157	

$^{*}p \leq .05$, $^{**}p \leq .01$, $^{***}p \leq .001$

Table 21. Supervisor ratings of TECHNICAL SKILL, controlling for ATCS's perceived degree of ACCEPTANCE in the facility and DELAY between graduation and hiring

	Program						
	MnATCTC	FAA Academy					
Dimension	($N = 63$)	($N = 95$)	Element	Label	Sum of Squares	*df*	*F*
TECHNICAL SKILL	1.84	2.09	Covariate	ACCEPTANCE	2.70	1	7.8[illegible]
			Covariate	Hiring DELAY	0.55	1	1.59
			Combined		3.25	2	4.71**
			Main effect	PROGRAM	0.95	1	2.74
			Model		4.19	3	4.05**
			Residual		52.07	151	
			Total		56.26	154	

$^{*}p \leq .05$, $^{**}p \leq .01$, $^{***}p \leq .001$

differences in the degree to which MnATCTC and FAA Academy graduates felt accepted at the facility but may have reflected real differences in performance.

The analysis of covariance for supervisor ratings of technical knowledge for the two groups is presented in Table 22. The pattern of results for technical knowledge was again similar to that of TEAMWORK, with PROGRAM accounting for a statistically significant portion of the overall variability in TECHNICAL KNOWLEDGE ratings, even after accounting for the separate and joint effects of acceptance and hiring delay. Finally, the analysis of the POTENTIAL to succeed ratings for the two groups is presented in Table 23. The results for POTENTIAL to succeed followed the same pattern as the TECHNICAL SKILL ratings, with ACCEPTANCE accounting for a statistically significant portion of the variability in the POTENTIAL to succeed ratings made by supervisors ($F = 15.04$, $p \leq .001$). Hiring DELAY was not a significant factor in this analysis, while PROGRAM was. The results suggest that the lower ratings of POTENTIAL to succeed given by supervisors to MnATCTC graduates in comparison to FAA Academy graduates could not be explained as the consequence of differences in the degree to which MnATCTC graduates were accepted in the facility. Rather, the supervisor ratings of POTENTIAL to succeed in the ATCS occupation may have reflected real differences in performance between the two groups.

Costs and benefits

Costs

Program costs. Accrued direct costs for the MnATCTC program consisted of a series of Congressional earmarks totaling $10.9M. Indirect costs included: (a) headquarters human resources management staff time; (b) site visits by FAA personnel; (c) CAMI evaluation staff time; (d) evaluation contracts; (e) program steering committee meetings; (f) regional liaison staff time; (g) FAA Academy staff time; and (h) Air Traffic staff time. The total time and costs associated with managing the CTI/ATCS program, as reported via e-mail, were prorated across the five participating institutions, except where those costs were explicitly attributed to MnATCTC only. A breakdown of those annual costs by fiscal year (FY) are presented in Appendix B; the logic of each annual costs worksheet is described in Table 24. To estimate the running cost-per-hire for the MnATCTC program, the cumulative costs each year were amortized over the cumulative actual and projected number of hires through that year. The cost per hire in 1991 was high, at about $281,000, reflecting initial start-up costs for the program. This cost-per-hire was reduced in 1992 to about $121,000 per MnATCTC graduate hired by the FAA. That cost was further reduced in 1993 to approximately $81,000 per hire as more MnATCTC graduates entered FAA service. With additional hiring in FY94, the MnATCTC cost-per-hire was stable at about $57,000 through FY95. The FY96 cost was projected to be about $50,000 per graduate with continued hiring.

Cost comparison. Actual and projected hiring for MnATCTC program graduates was used to estimate the likely cost per hire through the year 2003, as shown in Figure 3. The costs per controller at the FAA Academy under the redesigned "Train to Succeed" model were estimated by the Air Traffic Training Work Group (ATTWG, 1992) at about $33,000 through the PV phase. Slightly different cost figures can be obtained from the FAA Academy Tuition Pricing System (ATPS; FAA Academy, 1994). The per controller cost for basic en route training was estimated at about $58,000 in FY94 by ATPS. Finally, more recent figures, as coordinated with the FAA Academy, the Training Requirements Division (ATZ-100), and Assistant Director of the Office of Air Traffic Program Management (ATZ-2) as of April 1995 (Larry Lackey, personal communication, May 1995), estimated the Academy cost for initial resident training at $45,500 in the en route option[1]. The highest and lowest estimates were used to define a range for estimated Academy per-controller costs for comparison purposes.

This cost analysis suggests that MnATCTC is competitive with the FAA Academy, in terms of the costs to produce each graduate at about $50,000 per controller. With the projected hiring of 64 graduates in FY97, and as many as 100 in FY98 and beyond, MnATCTC per graduate costs may be lower than the FAA Academy's lowest estimated per controller cost. Continued hiring of MnATCTC graduates could reduce the fully amortized cost per MnATCTC hire to a level that is competitive with internal FAA

[1]The per-student expenditure rate at the FAA Academy includes incremental costs and excludes about $13.7 million in capital costs for the En Route program (Sweetman, personal communication, January 30, 1997).

Table 22. Supervisor ratings of TECHNICAL KNOWLEDGE, controlling for ATCS's perceived degree of ACCEPTANCE in the facility and DELAY between graduation and hiring

Dimension	Program: MnATCTC ($N = 63$)	Program: FAA Academy ($N = 95$)	Element	Label	Sum of Squares	*df*	*F*
KNOWLEDGE	2.19	2.56	Covariate	ACCEPTANCE	7.63	1	23.23***
			Covariate	Hiring DELAY	1.46	1	4.43*
			Combined		9.09	2	13.83***
			Main effect	PROGRAM	1.66	1	5.07*
			Model		10.75	3	10.91***
			Residual		50.27	153	
			Total		61.02	156	

*$p \leq .05$, **$p \leq .01$, ***$p \leq .001$

Table 23. Supervisor ratings of potential to succeed in occupation, controlling for ATCS's perceived degree of acceptance in the facility and delay between graduation and hiring

Dimension	Program: MnATCTC ($N = 63$)	Program: FAA Academy ($N = 95$)	Element	Label	Sum of Squares	*df*	*F*
POTENTIAL	79.94	86.08	Covariate	Acceptance	3811.96	1	15.04***
			Covariate	Hiring delay	8.09	1	0.03
			Combined		1910.02	2	7.54***
			Main effect	Program	2874.44	1	11.34***
			Model		6694.46	3	8.80***
			Residual		38527.10	152	
			Total		45221.60	155	

*$p \leq .05$, **$p \leq .01$, ***$p \leq .001$

Academy costs, despite an additional $1,700,000 in funding in FY97 (P.L. 104-205). Even with continuing subsidies to the Minnesota Air Traffic Control Training Program of $1.5 million per year, as requested in congressional testimony by the Director of that program (Pointer, March 1995), the cost per MnATCTC hire is likely to be very competitive with FAA Academy per controller costs in the en route option. Elimination of continued subsidies to the MnATCTC program in fiscal year 1997 and beyond, as recommended in the 1993 National Performance Review (p. 98) would only increase the cost advantage of the MnATCTC program over the FAA Academy in providing initial technical training for the en route option over the long term.

Benefits

Program benefits

A cost advantage, however, does not necessarily result in benefits to the taxpayer. Therefore, the next step was to analyze benefits accruing from the MnATCTC program relative to costs. Four classes of program benefits that could be clearly expressed in dollars were identified: (a) avoided screening costs; *(b) avoided Academy training costs; (c) avoided PV* costs; and (d) savings from reduced time to FPL. Screening costs refers to the agency costs in administering either the former FAA Academy ATCS Nonradar Screen program (Broach & Manning, 1994) through March 1992, or the replacement computerized ATCS Pre-Training Screen (Broach & Brecht-Clark, 1994) from June 1992 through June 1996. The costs of the former ATCS Nonradar Screen (FAA Academy course 50321) were estimated at about $10,000 per controller in 1991. The replacement computerized test battery cost about $1,500 per examinee (Broach & Brecht-Clark, 1994). The FAA avoided incurring these costs for MnATCTC graduates as they did not go through the Nonradar Screen or the ATCS Pre-Training Screen.

Avoided Academy training costs refers to costs incurred by the agency under the redesigned Academy program of about $45,500 per controller in the en route option. The redesigned FAA Academy program will consist of three phases or modules: academics (Phase I); techniques (Phase II); and skills building *(Phase III; Air Traffic Training Group, 1996). There* were no plans for MnATCTC graduates to attend any phase of the FAA Academy ATCS training program, as of 1995, thereby saving the agency approximately $45,500 per year per graduate hired.

Performance verification (PV) is the Air Traffic evaluation of the readiness of a trainee to enter the field for on-the-job training. PV was instituted in June 1992 as part of the overhaul of the ATCS curriculum by the ATTWG (1992). The core of PV requires bringing experienced field controllers in as evaluators for each trainee. The costs of PV based on (a) five days salary for a FG-14 FPL controller, (b) five days per diem in Oklahoma City, and (c) an average round-trip fare of $250. The rounded sum of these costs was prorated across four examinees to arrive at a cost estimate of about $500 per PV examinee. From 1992 through the present, the agency delegated the PV function to the schools under the supervision and direction of the Air Traffic Performance Verification Division (ATZ-400). Thus, the agency has avoided those PV costs between 1992 and the present. There are no plans for MnATCTC graduates to undergo PV at the FAA Academy, and the FAA will continue to avoid PV costs for these controllers.

The final category of benefit to the agency is in the *reduction of the time to* FPL. *The 1991 comprehen*sive review of ATCS training estimated en route field training costs over a 36 month average time to FPL at $131,739 (ATTWG, 1991a). This total cost was prorated over the three years to provide an estimate of the annual OJT cost of about $43,000. Reductions in time to FPL reduce the amount spent on training, which represents a savings to the agency.

Cost-benefit analysis

The cost-benefit analysis focused on determining the point at which cumulative program benefits would balance or exceed cumulative MnATCTC program costs. Costs were calculated from 1991 through the year 2003 as the sum, each year, of identified direct and indirect costs, as shown in each fiscal year's worksheet in Appendix B and Table 24. Benefits accrued from avoided costs were calculated for each year by multiplying the number of MnATCTC graduates hired by the avoided screening, three phases of initial qualification training at the FAA Academy, and PV costs, as shown in the cost-benefit analysis *worksheets in Appendix B. The logic of the cost*-benefit worksheet is presented in Table 25. The

Table 24. Annual FY costs worksheet logic

Cost Category	Description	N	Rate	Cost ($)
Direct = cost attributable or specific to the MnATCTC program	For example, financial subsidies provided at the direction of Congress	Units (not costs) allocated to MnATCTC program	Unit costs, for example, annual appropriation to MnATCTC	Units x rate = Cost
Program = indirect cost prorated to MnATCTC program	For example, FAA staff costs, evaluation costs, and travel. Staff costs are based on published locality-based pay rates for the grade/step of the FAA staff person.	Prorated units (not costs) or portion of FTE allocated to MnATCTC program	Unit costs, for example, GS-14 annual salary	Units x rate = Cost
			Annual Costs =	Sum of costs for this fiscal year
			Cumulative costs =	This year's costs + all previous years' costs back to 1991
	Annual hires =	This year's actual or projected number of MnATCTC graduates (to be) hired by FAA		
	Cumulative hires =	This year's hires + all previous years' hires back to 1991		
			Cost per hire =	Cumulative costs divided by cumulative hires

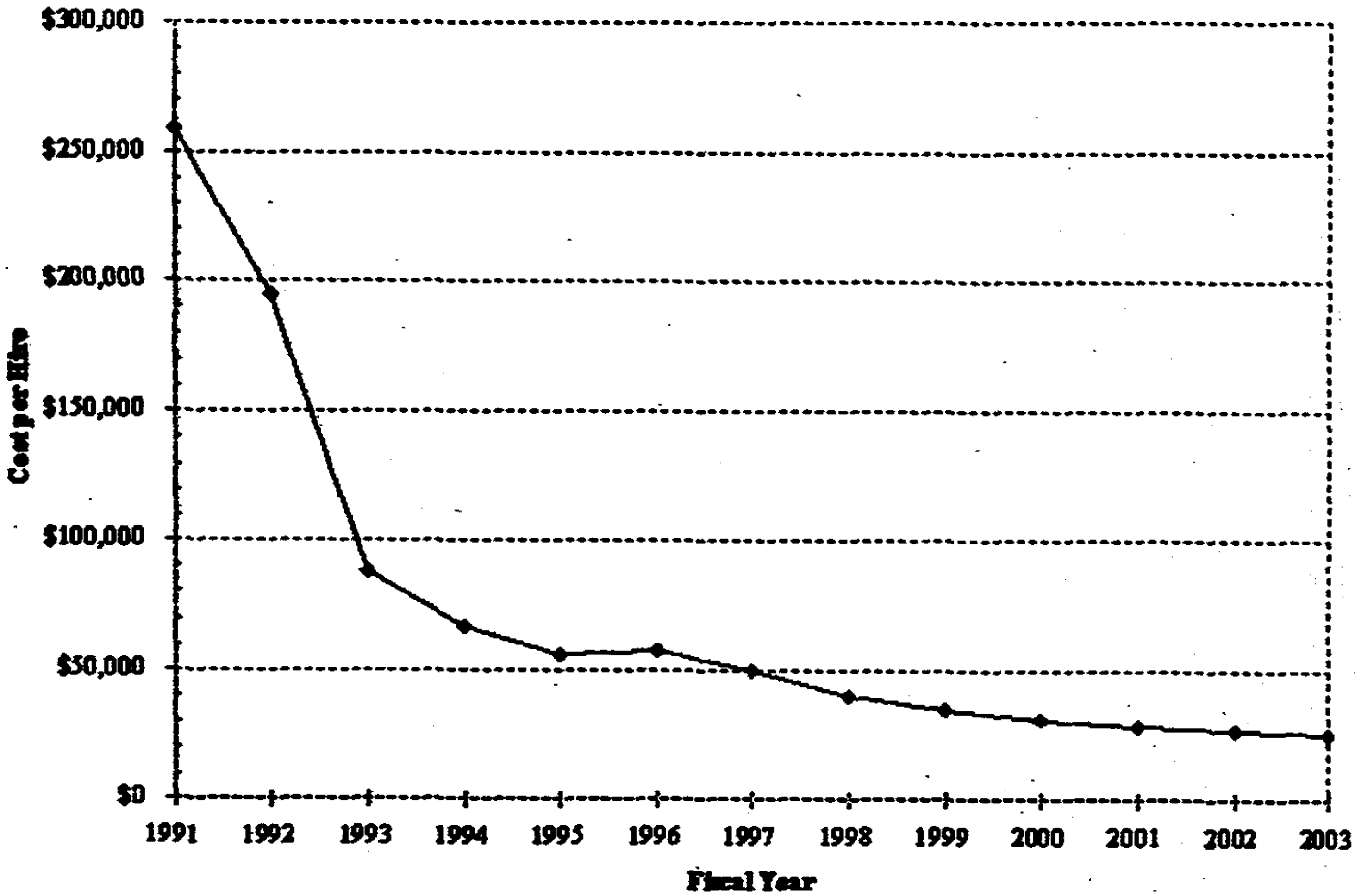

Figure 3. MnATCTC projected cost-per-hire

Table 25. Cost-benefit worksheet logic

Fiscal Year	Annual Number of MnATCTC Program Hires	Cumulative Number of MnATCTC Program Hires	FAA Screening Cost	Cumulative Savings from Avoided Screening Costs
Fiscal year (refer to FY worksheet)	Actual number of hires for FY worksheet	Cumulative number of hires from FY worksheet	Costs for FAA Academy Nonradar Screen FY91-92 ($10,000) or ATCS/PTS FY93-96 ($1,500). If $0 in cell, then cost not avoided	Number of annual hires for FY x Screening cost for that year, summed across years

(Columns continue across page in worksheet)

FAA Academy Academics (Phase I) Training Cost	FAA Academy Techniques (Phase II) Training Cost	FAA Academy Skills-building (Phase III) Training Cost	Cumulative Savings from Avoided FAA Academy Training Costs
Starting in FY93, estimated at $15,000 per student	Starting in FY93, estimated at $15,000 per student. If $0 entered, cost not avoided. $7,500 indicates 50% of cost avoided, by having MnATCTC enter mid-course in Phase II	Starting in FY93, estimated at $15,500 per student; $0 indicates cost not avoided by FAA	Number of annual hires for FY x (Phase I + Phase II + Phase III avoided costs), summed across years

(Table 25 continues)

(Table 25 continued)

(Columns continue across page in worksheet)

ATX-400 Performance Verification Cost per Student	Cumulative Savings from Avoided PV Costs	Reduction in Time to FPL (Years)	Average OJT Cost per Year	Annual Savings from Reduced Time to FPL
Estimated cost per student, as described in text; if $0, cost not avoided	Annual hires x PV cost per student, summed across years	Difference between MnATCTC average time to FPL and facility historical averages, computed as a standardized Z-score	x Estimated OJT cost as described in text	= Annual savings

Cumulative Savings from Reduced Time to FPL	Total Cumulative Savings (Avoided Screening, Training, PV, and Time to FPL Savings)	Cumulative MnATCTC program costs	MnATCTC Benefit-Cost Ratio	Cost-per-hire
Annual savings from reduced time to FPL, summed across years	sum of cumulative avoided screening costs, cumulative avoided FAA Academy training costs, avoided PV costs, plus cumulative savings from reduced time to FPL	Cumulative costs (to date) for MnATCTC from FY worksheet	= cumulative costs divided by cumulative savings (benefits)	Cumulative cost-per-hire from FY worksheet

reduction in time to FPL, while not statistically significant, was multiplied by the average OJT cost per year to assess the financial utility of even small gains in efficiency; that product was multiplied by the number of graduates per year to provide a rough estimate of savings attributable to reductions in time-to-FPL. Avoided costs and OJT savings were then summed.

The cumulative costs and benefits were then compared, as shown in Figure 4, to identify the probable time frame in which benefits accruing from the MnATCTC program might balance or exceed cumulative costs. Without considering other factors, such as the field training resource implications of the differing skill levels indicated by the ratings data, it appears that cumulative benefits to the FAA from the MnATCTC program might outweigh sunk costs by about FY1998, based on the projected hiring rates. The ratio of cumulative benefits to costs is illustrated in Figure 5. Overall, the MnATCTC program might return at least one dollar in avoided costs and savings for every dollar invested by FY1998, based on current projected hiring rates.

DISCUSSION

Overall, the CTI/ATCS program appears to be meeting its operational objectives in terms of employee diversity, progress in field training, and controller performance. The MnATCTC program appears to be providing a greater proportion of women to the field facilities than has been provided through the FAA Academy. However, the MnATCTC program does not appear to be a better source for minority controllers than existing workforce sources such as the FAA Academy. There are few significant differences between MnATCTC and FAA Academy graduates in terms of training measures after taking into account inter-facility differences in programs. MnATCTC graduates appear to do better than FAA Academy graduates on some training measures, and FAA Academy graduates do better on others. The net effect appears to be that, overall, MnATCTC graduates require about the same amount of days and hours of OJT as FAA Academy graduates. The attrition rates for the two groups are similar. A relatively small number of MnATCTC graduates had been certified

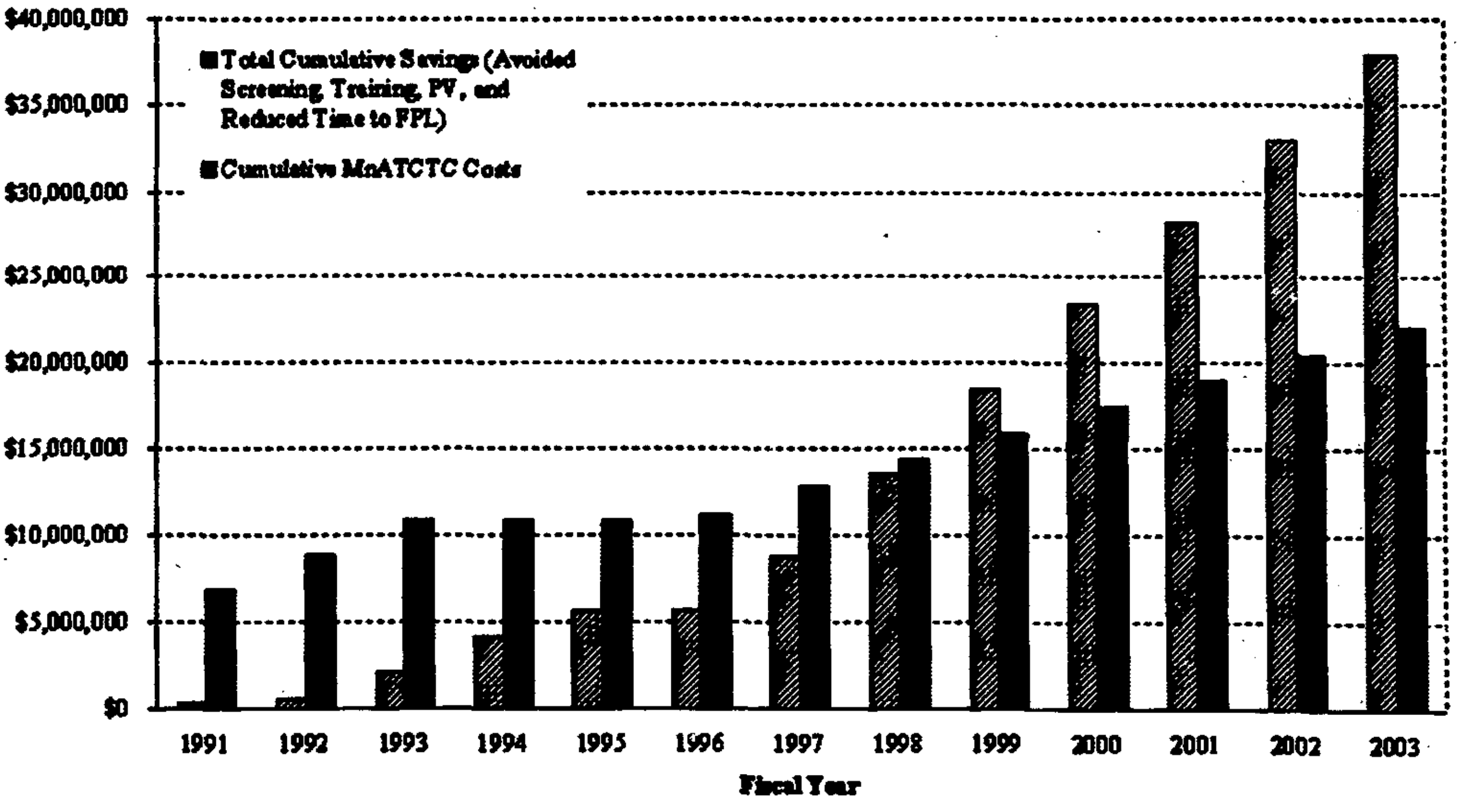

Figure 4. MnATCTC cumulative costs and benefits

as FPL controllers as of June 1995, compared with a larger number of FAA Academy graduates. However, the times required for the two groups to certify were about the same. Moreover, the accession analysis suggested that the number of MnATCTC graduates that could be reasonably expected to achieve FPL, and their times to FPL, are likely to be comparable to those for FAA Academy graduates.

On the other hand, the ratings data suggest some caution in concluding that the MnATCTC is producing graduates that are strictly comparable to graduates of the FAA Academy — in terms of their teamwork, technical skill, knowledge, and potential to succeed. Overall, the mean ratings of MnATCTC graduate teamwork, technical skill, knowledge, and potential to succeed were statistically lower than the mean ratings of the Academy comparison group, even after taking into account other factors, such as the degree to which graduates felt accepted at the facility and hiring delays. Alternative explanations for these difference might include discomfort with MnATCTC graduates and rating errors associated with stringency and leniency. Another explanation might be that FAA ATCS supervisors are as yet uncomfortable with controllers entering the work force through other than the traditional pipelines. Or, it may be that the differences in ratings reflect real differences in performance. The development of objective measures of the core technical performance of controllers, such as envisioned for the Separation and Control Hiring Assessment (SACHA) procurement (FAA, 1991) and its successor, the Air Traffic Selection and Training (AT-SAT) program (FAA, 1996), may provide better assessment tools in future program evaluations than subjective ratings that may be influenced by stringency, leniency, and other rating errors.

Finally, the cost-benefit data suggest that benefits may accrue to the agency by using MnATCTC as an alternative workforce recruiting and training source for the en route option. It appears from this analysis that MnATCTC can produce graduates at a cost that is competitive with the FAA Academy, even with continuing, congressionally-mandated financial support from the FAA for the Minnesota program. The cost-benefit analysis for MnATCTC also suggests that, given current hiring projections, the MnATCTC will have a positive return-on-investment by about FY1998. The majority of that benefit accrues in the form of avoided training costs at the FAA Academy. However, this analysis does not consider other costs to the agency. For example, the differences in skill level for MnATCTC graduates may place greater burdens over time on facility training resources to bring those graduates up to a common standard of

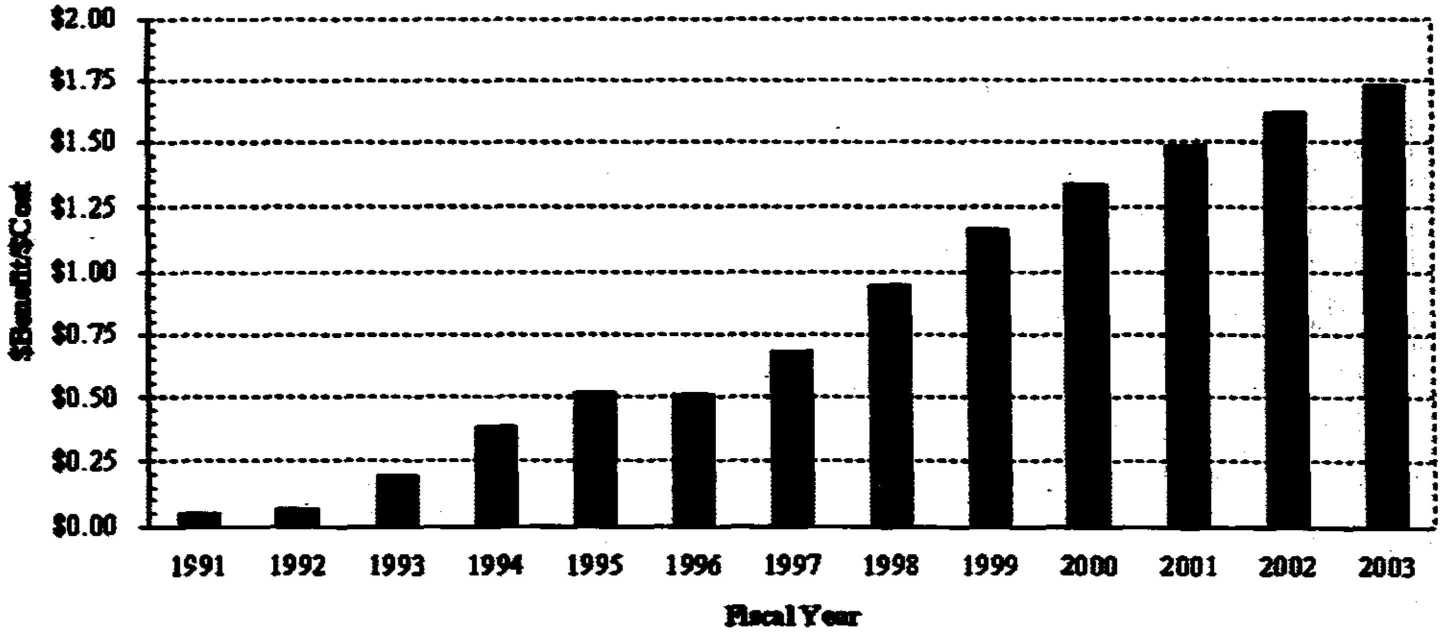

Figure 5. MnATCTC cumulative benefit-to-cost ratio

performance. A significant effort will be required of the FAA to recruit minority candidates for the ATCS occupation in view of the difficulties experienced by the MnATCTC to recruit a diverse student population. Maintaining the technological currency of the MnATCTC program on the NAS architecture as it evolves may impose another cost on the agency that is not reflected in this cost-benefit analysis. Moreover, improvements in efficiency at the FAA Academy, reducing agency costs, would reduce the apparent financial benefits of the MnATCTC program.

In conclusion, this first summative evaluation found, on one hand, that the MnATCTC program, under the Collegiate Training Initiative for Air Traffic Control Specialists (CTI/ATCS) umbrella, appears to be meeting defined program objectives, in terms of recruiting women into this traditionally male occupation. However, MnATCTC has been less successful than the FAA in recruiting minorities into the ATCS occupation, despite a substantial investment in a national recruiting program. MnATCTC graduate progress through the controller field training appears to be on a par with that of persons entering the occupation through the FAA Academy, based on the objective tracking and attrition data. However, the subjective ratings are less supportive, with MnATCTC graduates having lower average ratings of teamwork, technical skill, technical knowledge, and potential to succeed in the ATCS occupation than Academy graduates, even after controlling for the fact that MnATCTC graduates felt less well accepted in the facility and experienced significant delays between graduation and hiring. These differences may reflect actual performance differences, or perhaps, discomfort with persons entering the occupation through other than traditional routes. Research on supervisory attitudes and expectations of new controllers might provide a basis for understanding these differences in ratings and for designing training management interventions and strategies to mitigate any discomfort and ease the organizational socialization process for new controllers in field facilities. Differences in personality and biographical background between persons that enter through the collegiate and competitive channels might also be investigated as potential explanations for differences in performance. Objective measures of core technical performance, currently under development, may be used in future evaluations to provide a more definitive comparison of the safety and efficiency of CTI/ATCS graduates to that of controllers who entered the occupation through the FAA Academy. Finally, the cost-benefit analysis suggests some long-term benefit for the FAA by utilizing the MnATCTC program as an alternative workforce source. Overall, the pattern of results in this first summative evaluation suggests that expansion of the CTI/ATCS program to additional educational institutions might be considered by the FAA as part of an overall strategy for staffing the National Airspace System.

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Appendix A

Sample Performance Rating Packets

Date

[OJT Instructor]
[Facility]
[Mailing address]
[City, ST, Zip-xxxx]

Dear [OJT Instructor]

The Collegiate Training Initiative for Air Traffic Control Specialists (CTI) program was implemented by the agency in 1990 in order to assess the feasibility of developing and implementing initial, entry-level ATCS technical training at selected educational institutions throughout the country. [Controller] graduated from one of the five participating CTI schools, and was placed directly into a field facility without going through the initial training at the FAA Academy. This survey is part of a series of studies being conducted by the Civil Aeromedical Institute (CAMI) to evaluate the feasibility of the CTI program. These survey results will be used to assess how well the CTI programs have trained their graduates relative to FAA-trained developmentals.

In this evaluation, supervisors of and selected OJT instructors for the CTI graduates currently employed by the FAA will receive this CTI Controller Profile. In the survey, you are asked to assess the performance of [controller]— his or her technical skills, technical knowledge, and teamwork --- relative to all other controllers you have known at the same point in their career.

The same survey is being sent to the supervisors of and OJT instructors for a comparison group of FAA Academy-trained controllers, in order to provide a basis for comparing how well the CTI and Academy programs trained new controllers for success in field training. Similar surveys are also being sent to the controllers to obtain their self-assessments as well. The results of the self-, supervisor-, and instructor-assessments will be combined for each person, and then aggregated within groups for analysis. ***Let us stress to you that the focus of the study is on evaluating the CTI and Academy programs.***

In other words, only group statistics shall be used in any reports. Data about individuals are confidential, and shall not be released. ***The data collected in this study and its results shall not be used in any way, by any member, employee, representative, or contractor, of the agency to effect your assignments, training, working conditions, or status.*** The surveys shall not be retained, recorded, or copied in any way at the facility for any purpose.

Finally, the profile data from this survey are *vital* to evaluating the CTI program for the agency, the Department of Transportation, and the CTI schools. We strongly urge you to complete the survey and return it in the postage paid envelope as soon as possible.

/s/
[Name]
[Air Traffic title]

Collegiate Training Initiative (CTI) Graduate Profile

PURPOSE OF SURVEY

This survey is part of a series of studies to evaluate the Collegiate Training Initiative (CTI). Your first-hand impressions of the performance of [controller (SSN)] are very important to determining if the CTI program is accomplishing the goal of putting high-aptitude persons into the field.

BACKGROUND OF SURVEY

The CTI program was initially implemented in 1990. [controller] graduated from one of the 5 participating institutions. The purpose of this followup study is to assess the performance and progress of [controller] as part of the overall evaluation of the CTI.

THANKS FOR YOUR COOPERATION

The profile data from this survey are *vital* to evaluating the CTI for the agency. Your cooperation and thoughtful consideration of [controller]'s skills, teamwork, and knowledge is greatly appreciated — and needed.

A FINAL WORD

The researchers at CAMI know that it seems like there a lot of surveys in the FAA. This survey, however, has been mailed to a very specific group, as opposed to a more general sample like the *Job Satisfaction Survey*. We also know that, often, not much seems to ever be heard about the results of a survey. To combat this perception, we'd like to send a short summary of the results to you, when they become available. Just fill out a mailing label or envelope, and include it in the return envelope.

THANK YOU VERY MUCH!

Please remember that this survey:

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- Shall be used only for the evaluation of the CTI by CAMI researchers;
- Is confidential and only group statistics shall be used in any reports;
- Shall not be discussed with the controller or any other person;
- Shall not effect assignments, working conditions, or status of the controller; and
- Shall not be copied, recorded, or retained at the facility for any purpose.

TEAMWORK: **Consider the controller's teamwork, relative to all other controllers you have observed at the same point in training. Use the scale below to profile [controller]'s teamwork.**

[illegible]

③ = Very well

[illegible]

① = Marginally

[illegible]

Relative to all other controllers you have observed at the same point in their career, how well does this controller:

1.	Work in a team	①	③
2.	Engage other team members in solving a problem	①	③
3.	Lead the team in solving problems, making improvements, etc.	①	③
4.	Earn the respect of team members	①	③
5.	Build camadarie or spirit appropriately within the team	①	③
6.	Discourage horse play or other disruptive behavior	①	③
7.	Support or aid team members in stressful situations	①	③
8.	Maintain awareness of own ability limits	①	③
9.	Accept feedback regarding performance	①	③
10.	Seek additional information when confronted with a problem	①	③
11.	Evaluate alternative solutions to a problem	①	③
12.	Perform confidently	①	③
13.	Perform consistently day after day regardless of circumstances	①	③
14.	Adapt to changing conditions or circumstances on the job	①	③
15.	Tolerate stressful situations	①	③

④ = *Strongly*
③ = *Very much*
② = *To some degree*
① = *Not very much*
⓪ = *Can't say, don't know, or not applicable*

	Relative to all other controllers you have observed at this point in their career, to what degree do you believe that this controller:					
16.	Is part of the team	⓪	①	②	③	④
17.	Might be more accepted in another work group or team	⓪	①	②	③	④
18.	Fits in with his or her current work group or team	⓪	①	②	③	④
19.	Is treated fairly by her or his current work group or team	⓪	①	②	③	④
20.	Is affected negatively (with regard to work performance) by how the other controllers on his or her current team view her/him	⓪	①	②	③	④

SKILLS: Now consider the controller's **technical skill** in performing air traffic control tasks, relative to all other controllers you have observed at the same point in their career. Use the scale below to profile [controller]'s technical skills.

④ = *Exceptionally*
③ = *Very well*
② = *Acceptably*
① = *Marginally*
⓪ = *Can't say, don't know, or not applicable*

	Relative to all other controllers you have observed at this point in their career, how well does this controller:					
21.	Ensure separation using vectors, speed, & altitude	⓪	①	②	③	④
22.	Maintain an orderly flow of traffic	⓪	①	②	③	④
23.	Sequence traffic	⓪	①	②	③	④
24.	Perform pointouts and handoffs	⓪	①	②	③	④
25.	Manage (surface) traffic movement areas	⓪	①	②	③	④
26.	Recover from and correct errors, slips, and/or mistakes	⓪	①	②	③	④
27.	Prioritize actions	⓪	①	②	③	④
28.	Maintain situational awareness	⓪	①	②	③	④
29.	Issue clearances using appropriate phraseology	⓪	①	②	③	④
30.	Conduct relief briefing	⓪	①	②	③	④
31.	Post flight data on flight progress strips	⓪	①	②	③	④

KNOWLEDGE: Finally, consider the controller's **technical knowledge** about air traffic control, relative to all other controllers you have observed at the same point in training. Use the scale below to profile [controller]'s technical knowledge:

④ = [illegible]

③ = ***Much***

② = ***Some***

① = ***Very little***

⓪ = ***Can't say, don't know, or not applicable***

Relative to all other controllers you have observed at the same point in their career, how much does this controller know about:

32.	Airspace configuration in sector and/or area of specialization	⓪	①	②	③	④
33.	Traps, hot spots, and traffic patterns or flows in the sector/area	⓪	①	②	③	④
34.	Relevant sector/area LOAs and directives	⓪	①	②	③	④
35.	Relevant sector/area special procedures	⓪	①	②	③	④
36.	ATC equipment capabilities and limitations	⓪	①	②	③	④
37.	Aircraft types, characteristics, and performance limits	⓪	①	②	③	④
38.	Weather	⓪	①	②	③	④
39.	Facility general policies and procedures	⓪	①	②	③	④
40.	Other parts of the ATC system, such as FSS and AF	⓪	①	②	③	④
41.	FAA organization, general policies, and procedures	⓪	①	②	③	④
42.	Pilot roles, responsibilities, constraints, and workload	⓪	①	②	③	④

Based on your observations, what is [Controller name]'s overall potential to succeed in the ATC occupation (on a 40-100 scale) ☐☐☐

About how long have you supervised or trained [controller]? ☐☐ (Yrs) ☐☐ (Mths)

Please tell us a little about yourself:

	(Yrs)	(Mths)
About how long have you been an air traffic controller?	☐☐	☐☐
About how long have you been at this facility?	☐☐	☐☐
About how long have you been in your present position?	☐☐	☐☐

Are you a .... O Instructor O Supervisor O Manager

THANK YOU VERY MUCH!

Date

[Controller]
[Facility]
[Mailing address]
[City, ST, Zip-xxxx]

Dear [controller]

The Collegiate Training Initiative for Air Traffic Control Specialists (CTI) program was implemented by the agency in 1990 in order to assess the feasibility of developing and implementing initial, entry-level ATCS technical training at selected educational institutions throughout the country. As a graduate from one of the five participating CTI schools, you were placed directly into a field facility without going through the initial training at the FAA Academy. This survey is part of a series of studies being conducted by the Civil Aeromedical Institute (CAMI) to evaluate the feasibility of the CTI program. These survey results will be used to assess how well the CTI programs have trained their graduates relative to FAA-trained developmentals.

In this evaluation, all of the CTI graduates currently employed by the FAA will receive this CTI Controller Profile. In the survey, you are asked to assess your own performance --- your technical skills, your technical knowledge, and teamwork --- relative to all other controllers you have known at the same point in their career. We are asking you directly because the research literature suggests that people in fact can and do give very honest self-assessments when asked. People know their strengths and where they need training or practice.

The same survey is being sent to a comparison group of FAA Academy-trained controllers, in order to provide a basis for comparing how well the CTI and Academy programs trained new controllers for success in field training. Similar surveys are also being sent to your supervisor and senior OJT instructor in order to get their assessments as well. The results of the self-, supervisor-, and instructor-assessments will be combined for each person, and then aggregated within groups for analysis. ***Let us stress to you that the focus of the study is on evaluating the CTI and Academy programs, not on individuals.***

In other words, only group statistics shall be used in any reports. Data about individuals are confidential, and shall not be released. ***The data collected in this study and its results shall not be used in any way, by any member, employee, representative, or contractor, of the agency to effect your assignments, training, working conditions, or status.***

Finally, you will be given time at work to complete this survey. The profile data from this survey from each and every CTI graduate are *vital* to evaluating the CTI program for the agency, the Department of Transportation, and the CTI schools. While participation is voluntary, we strongly urge you to complete the survey and return it in the postage paid envelope as soon as possible.

/s/
[Name]
[Air Traffic title]

/s/
[Name]
[AHT title]

Collegiate Training Initiative (CTI) Graduate Profile

PURPOSE OF SURVEY

This survey is part of a series of studies to evaluate the Collegiate Training Initiative (CTI). [controller], your assessment of your own performance is very important to determining if the CTI program is accomplishing the goal of putting high-aptitude persons into the field.

BACKGROUND OF SURVEY

The CTI program was initially implemented in 1990. Our records indicate that you graduated from one of the 5 participating institutions. The purpose of this followup study, [controller], is to assess the performance and progress of CTI graduates as part of the overall evaluation of the CTI.

THANKS FOR YOUR COOPERATION

The profile data from this survey are *vital* to evaluating the CTI for the agency. Your cooperation and thoughtful self-assessment of your technical skills, teamwork, and knowledge is greatly appreciated --- and needed.

A FINAL WORD

The researchers at CAMI know that it seems like there a lot of surveys in the FAA. This survey, however, has been mailed to a very specific group, as opposed to a more general sample like the *Job Satisfaction Survey*. We also know that, often, not much seems to ever be heard about the results of a survey. To combat this perception, we'd like to send a short summary of the results to you, when they become available. Just fill out a mailing label or envelope, and include it in the return envelope.

THANK YOU VERY MUCH!

Please remember that this survey:

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- Is confidential and only group statistics shall be used in any reports;
- Shall not be discussed with your OJTI, supervisor, or any other person;
- Shall not effect your assignments, working conditions, or status; and
- Shall not be copied, recorded, or retained at the facility for any purpose.

TEAMWORK: Consider your **teamwork**, relative to all other controllers you have known at the same point in training. Use the scale below to profile your teamwork.

④ = Exceptionally
③ = Very well
② = Acceptably
① = Marginally
⓪ = Can't say, don't know, or not applicable

Relative to all other controllers you have known at the same point in their career as you, how well do you:

1.	Work in a team	⓪	①	②	③	④
2.	Engage other team members in solving a problem	⓪	①	②	③	④
3.	Lead the team in solving problems, making improvements, etc.	⓪	①	②	③	④
4.	Earn the respect of team members	⓪	①	②	③	④
5.	Build camadarie or spirit appropriately within the team	⓪	①	②	③	④
6.	Discourage horse play or other disruptive behavior	⓪	①	②	③	④
7.	Support or aid team members in stressful situations	⓪	①	②	③	④
8.	Maintain awareness of own ability limits	⓪	①	②	③	④
9.	Accept feedback regarding performance	⓪	①	②	③	④
10.	Seek additional information when confronted with a problem	⓪	①	②	③	④
11.	Evaluate alternative solutions to a problem	⓪	①	②	③	④
12.	Perform confidently	⓪	①	②	③	④
13.	Perform consistently day after day regardless of circumstances	⓪	①	②	③	④
14.	Adapt to changing conditions or circumstances on the job	⓪	①	②	③	④
15.	Tolerate stressful situations	⓪	①	②	③	④

④ = *Strongly*
③ = *Very much*
② = *To some degree*
① = *Not very much*
⓪ = *Can't say, don't know, or not applicable*

Relative to all other controllers you have known at the same point in their career as you, to what degree do you believe that you:

16.	Are part of the team	⓪	①	②	③	④
17.	Might be more accepted in another work group or team	⓪	①	②	③	④
18.	Fit in with your current work group or team	⓪	①	②	③	④
19.	Are treated fairly by your current work group or team	⓪	①	②	③	④
20.	Are affected negatively (with regard to work performance) by how the other controllers on your current team view you	⓪	①	②	③	④

SKILLS: Now consider your **technical skill** in performing air traffic control tasks, relative to all other controllers you have known at the same point in training. Use the scale below to profile your technical skills.

④ = *Exceptionally*
③ = *Very well*
② = *[illegible]*
① = *Marginally*
⓪ = *Can't say, don't know, or not applicable*

Relative to all other controllers you have known at the same point in their career as you, how well do you:

21.	Ensure separation using vectors, speed, & altitude	⓪	①	②	③	④
22.	Maintain an orderly flow of traffic	⓪	①	②	③	④
23.	Sequence traffic	⓪	①	②	③	④
24.	Perform pointouts and handoffs	⓪	①	②	③	④
25.	Manage (surface) traffic movement areas	⓪	①	②	③	④
26.	Recover from and correct errors, slips, and/or mistakes	⓪	①	②	③	④
27.	Prioritize actions	⓪	①	②	③	④
28.	Maintain situational awareness	⓪	①	②	③	④
29.	Issue clearances using appropriate phraseology	⓪	①	②	③	④
30.	Conduct relief briefing	⓪	①	②	③	④
31.	Post flight data on flight progress strips	⓪	①	②	③	④

KNOWLEDGE: Finally, consider your **technical knowledge** about air traffic control, relative to all other controllers you have known at the same point in training. Use the scale below to profile your technical knowledge:

- ④ = *Most everything*
- ③ = *Much*
- ② = *Some*
- ① = *Very little*
- ⓪ = *Can't say, don't know, or not applicable*

Relative to all other controllers you have observed at the same point in their career as you, how much do you know about:

		⓪	①	②	③	④
32.	Airspace configuration in sector and/or area of specialization	⓪	①	②	③	④
33.	Traps, hot spots, and traffic patterns or flows in the sector/area	⓪	①	②	③	④
34.	Relevant sector/area LOAs and directives	⓪	①	②	③	④
35.	Relevant sector/area special procedures	⓪	①	②	③	④
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38.	Weather	⓪	①	②	③	④
39.	Facility general policies and procedures	⓪	①	②	③	④
40.	Other parts of the ATC system, such as FSS and AF	⓪	①	②	③	④
41.	FAA organization, general policies, and procedures	⓪	①	②	③	④
42.	Pilot roles, responsibilities, constraints, and workload	⓪	①	②	③	④

Based on your self-assessment, [controller], what is your overall potential to succeed in the ATC occupation (on a 40-100 scale) .... [ ][ ][ ]

About how long did you have to wait between graduating and starting the first phase of field training at your facility? .... [ ][ ] (Yrs) [ ][ ] (Mths)

THANK YOU VERY MUCH!

Date

[Supervisor]
[Facility]
[Mailing address]
[City, ST, Zip-xxxx]

Dear [supervisor]

The Collegiate Training Initiative for Air Traffic Control Specialists (CTI) program was implemented by the agency in 1990 in order to assess the feasibility of developing and implementing initial, entry-level ATCS technical training at selected educational institutions throughout the country. [Controller] graduated from one of the five participating CTI schools, and was placed directly into a field facility without going through the initial training at the FAA Academy. This survey is part of a series of studies being conducted by the Civil Aeromedical Institute (CAMI) to evaluate the feasibility of the CTI program. These survey results will be used to assess how well the CTI programs have trained their graduates relative to FAA-trained developmentals.

In this evaluation, supervisors of and selected OJT instructors for the CTI graduates currently employed by the FAA will receive this CTI Controller Profile. In the survey, you are asked to assess the performance of [controller]— his or her technical skills, technical knowledge, and teamwork — relative to all other controllers you have known at the same point in their career.

The same survey is being sent to the supervisors of and OJT instructors for a comparison group of FAA Academy-trained controllers, in order to provide a basis for comparing how well the CTI and Academy programs trained new controllers for success in field training. Similar surveys are also being sent to the controllers to obtain their self-assessments as well. The results of the self-, supervisor-, and instructor-assessments will be combined for each person, and then aggregated within groups for analysis. ***Let us stress to you that the focus of the study is on evaluating the CTI and Academy programs.***

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Finally, the profile data from this survey are *vital* to evaluating the CTI program for the agency, the Department of Transportation, and the CTI schools. We strongly urge you to complete the survey and return it in the postage paid envelope as soon as possible.

/s/
[Name]
[Air Traffic title]

Collegiate Training Initiative (CTI) Graduate Profile

PURPOSE OF SURVEY

This survey is part of a series of studies to evaluate the Collegiate Training Initiative (CTI). Your first-hand impressions of the performance of [controller (SSN)] are very important to determining if the CTI program is accomplishing the goal of putting high-aptitude persons into the field.

BACKGROUND OF SURVEY

The CTI program was initially implemented in 1990. [controller] graduated from one of the 5 participating institutions. The purpose of this followup study is to assess the performance and progress of [controller] as part of the overall evaluation of the CTI.

THANKS FOR YOUR COOPERATION

The profile data from this survey are *vital* to evaluating the CTI for the agency. Your cooperation and thoughtful consideration of [controller]'s skills, teamwork, and knowledge is greatly appreciated --- and needed.

A FINAL WORD

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- Shall not effect assignments, working conditions, or status of the controller; and
- Shall not be copied, recorded, or retained at the facility for any purpose.

TEAMWORK: Consider the controller's **teamwork**, relative to all other controllers you have observed at the same point in training. Use the scale below to profile [controller]'s teamwork.

④ = Exceptionally
③ = Very well
② = Acceptably
① = Marginally
⓪ = Can't say, don't know, or not applicable

Relative to all other controllers you have observed at the same point in their career, how well does this controller:

		⓪	①	②	③	④
1.	Work in a team	⓪	①	②	③	④
2.	Engage other team members in solving a problem	⓪	①	②	③	④
3.	Lead the team in solving problems, making improvements, etc.	⓪	①	②	③	④
4.	Earn the respect of team members	⓪	①	②	③	④
5.	Build camadarie or spirit appropriately within the team	⓪	①	②	③	④
6.	Discourage horse play or other disruptive behavior	⓪	①	②	③	④
7.	Support or aid team members in stressful situations	⓪	①	②	③	④
8.	Maintain awareness of own ability limits	⓪	①	②	③	④
9.	Accept feedback regarding performance	⓪	①	②	③	④
10.	Seek additional information when confronted with a problem	⓪	①	②	③	④
11.	Evaluate alternative solutions to a problem	⓪	①	②	③	④
12.	Perform confidently	⓪	①	②	③	④
13.	Perform consistently day after day regardless of circumstances	⓪	①	②	③	④
14.	Adapt to changing conditions or circumstances on the job	⓪	①	②	③	④
15.	Tolerate stressful situations	⓪	①	②	③	④

④ = Strongly

③ = Very much

② = To some degree

① = Not very much

⓪ = Can't say, don't know, or not applicable

	Relative to all other controllers you have observed at this point in their career, to what degree do you believe that this controller:					
16.	Is part of the team	⓪	①	②	③	④
17.	Might be more accepted in another work group or team	⓪	①	②	③	④
18.	Fits in with his or her current work group or team	⓪	①	②	③	④
19.	Is treated fairly by her or his current work group or team	⓪	①	②	③	④
20.	Is affected negatively (with regard to work performance) by how the other controllers on his or her current team view her/him	⓪	①	②	③	④

SKILLS: Now consider the controller's **technical skill** in performing air traffic control tasks, relative to all other controllers you have observed at the same point in their career. Use the scale below to profile [controller]'s technical skills.

④ = Exceptionally

③ = Very well

② = Acceptably

① = Marginally

⓪ = Can't say, don't know, or not applicable

	Relative to all other controllers you have observed at this point in their career, how well does this controller:					
21.	Ensure separation using vectors, speed, & altitude	⓪	①	②	③	④
22.	Maintain an orderly flow of traffic	⓪	①	②	③	④
23.	Sequence traffic	⓪	①	②	③	④
24.	Perform pointouts and handoffs	⓪	①	②	③	④
25.	Manage (surface) traffic movement areas	⓪	①	②	③	④
26.	Recover from and correct errors, slips, and/or mistakes	⓪	①	②	③	④
27.	Prioritize actions	⓪	①	②	③	④
28.	Maintain situational awareness	⓪	①	②	③	④
29.	Issue clearances using appropriate phraseology	⓪	①	②	③	④
30.	Conduct relief briefing	⓪	①	②	③	④
31.	Post flight data on flight progress strips	⓪	①	②	③	④

KNOWLEDGE: Finally, consider the controller's **technical knowledge** about air traffic control, relative to all other controllers you have observed at the same point in training. Use the scale below to profile [controller]'s technical knowledge:

- ④ = ***Most everything***
- ③ = ***Much***
- ② = ***Some***
- ① = ***Very little***
- ⓪ = ***Can't say, don't know, or not applicable***

Relative to all other controllers you have observed at the same point in their career, how much does this controller know about:

32.	Airspace configuration in sector and/or area of specialization	⓪	①	②	③	④
33.	Traps, hot spots, and traffic patterns or flows in the sector/area	⓪	①	②	③	④
34.	Relevant sector/area LOAs and directives	⓪	①	②	③	④
35.	Relevant sector/area special procedures	⓪	①	②	③	④
36.	ATC equipment capabilities and limitations	⓪	①	②	③	④
37.	Aircraft types, characteristics, and performance limits	⓪	①	②	③	④
38.	Weather	⓪	①	②	③	④
39.	Facility general policies and procedures	⓪	①	②	③	④
40.	Other parts of the ATC system, such as FSS and AF	⓪	①	②	③	④
41.	FAA organization, general policies, and procedures	⓪	①	②	③	④
42.	Pilot roles, responsibilities, constraints, and workload	⓪	①	②	③	④

Based on your observations, what is [Controller name]'s overall potential to succeed in the ATC occupation (on a 40-100 scale) .... ☐☐☐

About how long have you supervised or trained [controller]? .... ☐☐ (Yrs) ☐☐ (Mths)

Please tell us a little about yourself:

	(Yrs)	(Mths)
About how long have you been an air traffic controller?	☐☐	☐☐
About how long have you been at this facility?	☐☐	☐☐
About how long have you been in your present position?	☐☐	☐☐

Are you a .... O Instructor O Supervisor O Manager

THANK YOU VERY MUCH!

Appendix B

Cost-Benefit Analysis Model Worksheets

Table B-1
FY1991 MnATCTC Cost estimate worksheet

Cost Category	Description	N	Rate	$
Direct	FAA Financial Support	1.00	$6,650,000	$6,650,000
Direct	Site Visits	6.00	$500	$3,000
Direct	Regional Liaison (GS-14/5)	1.00	$59,394	$59,394
Program	AHT Staff (GS-14/5)	0.25	$59,394	$14,849
Program	AAM Psychologist (GS-12/1)	0.10	$37,294	$3,729
Program	Evaluation Contract(s)	0.00	$0	$0
Program	APN Staff (GS-13/5)	0.00	$50,260	$0
Program	AMH Staff (GS-7/2)	0.00	$21,724	$0
Program	AMA Staff (GS-14/5)	0.01	$59,394	$594
Program	ATZ Staff (GS-14/5)	0.04	$59,394	$2,376
			Annual Costs	$6,733,942
			Cumulative Costs	$6,733,942
	Annual Hires	26		
	Cumulative Hires	26		
			Cost per Hire	$258,998

Table B-2
FY1992 MnATCTC Cost estimate worksheet

Cost Category	Description	N	Rate	$
Direct	FAA Financial Support	1.00	$2,000,000	$2,000,000
Direct	Site Visits	1.00	$500	$500
Direct	Regional Liaison (GS-14/5)	0.00	$61,887	$0
Program	AHT Staff (GS-14/5)	0.05	$61,887	$3,094
Program	AAM Psychologist (GS-12/2)	0.10	$40,156	$4,016
Program	Evaluation Contract(s)	0.00	$0	$0
Program	APN Staff (GS-13/9)	0.10	$58,530	$5,853
Program	AMH Staff (GS-7/3)	0.00	$23,366	$0
Program	AMA Staff (GS-14/5)	0.01	$61,887	$619
Program	ATZ Staff (GS-14/5)	0.04	$61,887	$2,475
			Annual Costs	$2,016,557
			Cumulative Costs	$8,750,499
	Annual Hires	19		
	Cumulative Hires	45		
			Cost per Hire	$194,456

Table B-3
FY1993 MnATCTC Cost estimate worksheet

Cost Category	Description	N	Rate	$
Direct	FAA Financial Support	1.00	$2,000,000	$2,000,000
Direct	Site Visits	1.00	$500	$500
Direct	Regional Liaison (GS-14/5)	0.50	$64,179	$32,090
Program	AHT Staff (GS-14/5)	0.04	$64,179	$2,567
Program	AAM Psychologist (GS-13/1)	0.02	$47,920	$958
Program	Evaluation Contract(s)	0.20	$97,000	$19,400
Program	APN Staff (GS-13/9)	0.07	$60,696	$4,249
Program	AMH Staff (GS-7/4)	0.12	$24,988	$2,999
Program	AMA Staff (GS-14/5)	0.01	$64,179	$642
Program	ATZ Staff (GS-14/5)	0.01	$64,179	$642
			Annual Costs	$2,064,046
			Cumulative Costs	$10,814,545
	Annual Hires	78		
	Cumulative Hires	123		
			Cost per Hire	$87,923

Table B-4
FY1994 MnATCTC Cost estimate worksheet

Cost Category	Description	N	Rate	$
Direct	FAA Financial Support	1.00	$0	$0
Direct	Site Visits	1.00	$500	$500
Direct	Regional Liaison (GS-14/5)	0.01	$64,179	$642
Program	AHT Staff (GS-14/6)*	0.10	$68,862	$6,886
Program	AAM Psychologist (GS-13/2)	0.10	$51,171	$5,117
Program	Evaluation Contract(s)	0.00	$0	$0
Program	APN Staff (GS-13/10)*	0.10	$64,928	$6,493
Program	AMH Staff (GS-7/4)	0.12	$25,823	$3,099
Program	AMA Staff (GS-14/5)	0.01	$66,323	$663
Program	ATZ Staff (GS-14/5)*	0.02	$66,323	$1,326
	**Locality pay*		Annual Costs	$24,726
			Cumulative Costs	$10,839,271
	Annual Hires	40		
	Cumulative Hires	163		
			Cost per Hire	$66,499

Table B-5
FY1995 MnATCTC Cost estimate worksheet

Cost Category	Description	N	Rate	$
Direct	FAA Financial Support	1.00	$0	$0
Direct	Site Visits	0.00	$2,000	$0
Direct	Regional Liaison (GS-14/5)	0.01	$65,460	$655
Program	AHR-15 Staff (GS-14/6)*	0.02	$71,078	$1,422
Program	AAM Psychologist (GS-13/3)*	0.10	$52,136	$5,214
Program	*Evaluation Contract(s)*	*0.00*	*$0*	*$0*
Program	AHR-22 Staff (GS-13/10)*	0.05	$67,021	$3,351
Program	AMH Staff (GS-7/5)*	0.12	$26,529	$3,183
Program	AMA Staff (GS-14/5)*	0.01	$65,460	$655
Program	ATZ STaff (GS-14/5)*	0.02	$69,047	$1,381
	**Locality pay*		Annual Costs	$15,860
			Cumulative Costs	$10,855,131
	Annual Hires	30		
	Cumulative Hires	193		
			Cost per Hire	$56,244

Table B-6
FY1996 MnATCTC Cost estimate worksheet

Cost Category	Description	N	Rate	$
Direct	FAA Financial Support	1.00	$250,000	$250,000
Direct	Site Visits	0.00	$0	$0
Direct	Regional Liaison (GS-14/5)	0.01	$65,460	$655
Program	AHR-15 Staff (GS-14/6)*	0.05	$71,078	$3,554
Program	AAM Psychologist (GS-14/1)*	0.10	$57,760	$5,776
Program	Evaluation Contract(s)	0.20	$0	$0
Program	AHR-22 Staff (GS-13/10)*	0.05	$67,021	$3,351
Program	AMH Staff (GS-7/5)*	0.12	$26,529	$3,183
Program	AMA Staff (GS-14/5)*	0.01	$65,460	$655
Program	ATZ Staff (GS-14/5)*	0.02	$69,047	$1,381
	**Locality pay*		Annual Costs	$268,555
			Cumulative Costs	$11,123,686
	Annual Hires	0		
	Cumulative Hires	193		
			Cost per Hire	$57,636

Table B-7
FY1997 MnATCTC Cost estimate worksheet

Cost Category	Description	N	Rate	$
Direct	FAA Financial Support	1.00	$1,700,000	$1,700,000
Direct	Site Visits	0.00	$0	$0
Direct	Regional Liaison (GS-14/5)	0.01	$65,460	$655
Program	AHR-15 Staff (GS-14/7)*	0.05	$73,108	$3,655
Program	AAM Psychologist (GS-14/2)*	0.10	$59,685	$5,969
Program	Evaluation Contract(s)	0.20	$0	$0
Program	AHR-22 Staff (GS-13/10)*	0.05	$67,021	$3,351
Program	AMH Staff (GS-7/6)*	0.12	$27,031	$3,244
Program	AMA Staff (GS-14/6)*	0.01	$67,385	$674
Program	ATZ Staff (GS-14/6)*	0.02	$71,078	$1,422
	Locality pay		Annual Costs	$1,718,969
			Cumulative Costs	$12,842,654
	Annual Hires	64		
	Cumulative Hires	257		
			Cost per Hire	$49,971

Table B-8
FY1998 MnATCTC Cost estimate worksheet

Cost Category	Description	N	Rate	$
Direct	FAA Financial Support	1.00	$1,500,000	$1,500,000
Direct	Site Visits	0.00	$0	$0
Direct	Regional Liaison (GS-14/5)	0.01	$65,460	$655
Program	AHR-15 Staff (GS-14/7)*	0.05	$73,108	$3,655
Program	AAM Psychologist (GS-14/2)*	0.10	$59,685	$5,969
Program	Evaluation Contract(s)	0.20	$0	$0
Program	AHR-22 Staff (GS-13/10)*	0.05	$67,021	$3,351
Program	AMH Staff (GS-7/6)*	0.12	$27,031	$3,244
Program	AMA Staff (GS-14/6)*	0.01	$67,385	$674
Program	ATZ Staff (GS-14/6)*	0.02	$71,078	$1,422
	Locality pay		Annual Costs	$1,518,969
			Cumulative Costs	$14,361,623
	Annual Hires	100		
	Cumulative Hires	357		
			Cost per Hire	$40,229

Table B-9
FY1999 MnATCTC Cost estimate worksheet

Cost Category	Description	N	Rate	$
Direct	FAA Financial Support	1.00	$1,500,000	$1,500,000
Direct	Site Visits	0.00	$500	$0
Direct	Regional Liaison (GS-14/5)	0.01	$65,460	$655
Program	AHR-15 Staff (GS-14/8)*	0.05	$75,139	$3,757
Program	AAM Psychologist (GS-14/3)*	0.10	$61,610	$6,161
Program	Evaluation Contract(s)	0.20	$0	$0
Program	AHR-22 Staff (GS-13/10)*	0.05	$67,021	$3,351
Program	AMH Staff (GS-7/7)*	0.12	$27,803	$3,336
Program	AMA Staff (GS-14/7)*	0.01	$69,310	$693
Program	ATZ Staff (GS-14/7)*	0.02	$73,108	$1,462
	**Locality pay*		Annual Costs	$1,519,415
			Cumulative Costs	$15,881,038
	Annual Hires	100		
	Cumulative Hires	457		
			Cost per Hire	$34,751

Table B-10
FY2000 MnATCTC Cost estimate worksheet

Cost Category	Description	N	Rate	$
Direct	FAA Financial Support	1.00	$1,500,000	$1,500,000
Direct	Site Visits	0.00	$500	$0
Direct	Regional Liaison (GS-14/5)	0.01	$65,460	$655
Program	AHR-15 Staff (GS-14/8)*	0.05	$75,139	$3,757
Program	AAM Psychologist (GS-14/3)*	0.10	$61,610	$6,161
Program	Evaluation Contract(s)	0.20	$0	$0
Program	AHR-22 Staff (GS-13/10)*	0.05	$67,021	$3,351
Program	AMH Staff (GS-7/7)*	0.12	$27,803	$3,336
Program	AMA Staff (GS-14/7)*	0.01	$69,310	$693
Program	ATZ Staff (GS-14/7)*	0.02	$73,108	$1,462
	**Locality pay*		Annual Costs	$1,519,415
			Cumulative Costs	$17,400,453
	Annual Hires	100		
	Cumulative Hires	557		
			Cost per Hire	$31,240

Table B-11
FY2001 MnATCTC Cost estimate worksheet

Cost Category	Description	N	Rate	$
Direct	FAA Financial Support	1.00	$1,500,000	$1,500,000
Direct	Site Visits	0.00	$500	$0
Direct	Regional Liaison (GS-14/5)	0.01	$65,460	$655
Program	AHR-15 Staff (GS-14/8)*	0.05	$75,139	$3,757
Program	AAM Psychologist (GS-14/3)*	0.10	$61,610	$6,161
Program	Evaluation Contract(s)	0.20	$0	$0
Program	AHR-22 Staff (GS-13/10)*	0.05	$67,021	$3,351
Program	AMH Staff (GS-7/7)*	0.12	$27,803	$3,336
Program	AMA Staff (GS-14/7)*	0.01	$69,310	$693
Program	ATZ Staff (GS-14/7)*	0.02	$73,108	$1,462
	**Locality pay*		Annual Costs	$1,519,415
			Cumulative Costs	$18,919,869
	Annual Hires	100		
	Cumulative Hires	657		
			Cost per Hire	$28,797

Table B-12
FY2002 MnATCTC Cost estimate worksheet

Cost Category	Description	N	Rate	$
Direct	FAA Financial Support	1.00	$1,500,000	$1,500,000
Direct	Site Visits	0.00	$500	$0
Direct	Regional Liaison (GS-14/5)	0.01	$65,460	$655
Program	AHR-15 Staff (GS-14/8)*	0.05	$75,139	$3,757
Program	AAM Psychologist (GS-14/3)*	0.10	$61,610	$6,161
Program	Evaluation Contract(s)	0.20	$0	$0
Program	AHR-22 Staff (GS-13/10)*	0.05	$67,021	$3,351
Program	AMH Staff (GS-7/7)*	0.12	$27,803	$3,336
Program	AMA Staff (GS-14/7)*	0.01	$69,310	$693
Program	ATZ Staff (GS-14/7)*	0.02	$73,108	$1,462
	**Locality pay*		Annual Costs	$1,519,415
			Cumulative Costs	$20,439,284
	Annual Hires	100		
	Cumulative Hires	757		
			Cost per Hire	$27,000

Table B-13
<u>FY2003 MnATCTC Cost estimate worksheet</u>

Cost Category	Description	N	Rate	$
Direct	FAA Financial Support	1.00	$1,500,000	$1,500,000
Direct	Site Visits	0.00	$500	$0
Direct	Regional Liaison (GS-14/5)	0.01	$65,460	$655
Program	AHR-15 Staff (GS-14/8)*	0.05	$75,139	$3,757
Program	AAM Psychologist (GS-14/3)*	0.10	$61,610	$6,161
Program	Evaluation Contract(s)	0.20	$0	$0
Program	AHR-22 Staff (GS-13/10)*	0.05	$67,021	$3,351
Program	AMH Staff (GS-7/7)*	0.12	$27,803	$3,336
Program	AMA Staff (GS-14/7)*	0.01	$69,310	$693
Program	ATZ Staff (GS-14/7)*	0.02	$73,108	$1,462
	**Locality pay*		Annual Costs	$1,519,415
			Cumulative Costs	$21,958,699
	Annual Hires	100		
	Cumulative Hires	857		
			Cost per Hire	$25,623

Table B-14
<u>Overall cost-benefit estimate worksheet</u>

	MnATCTC hires by FAA		FAA Screening		FAA Academy			
FY	Annual	Cumulative	Screening cost	Cumulative avoided costs	Academics (Phase I) cost	Techniques (Phase II) cost	Skills-building (Phase III) cost	Cumulative avoided costs
1991	26	26	$10,000	$260,000				
1992	19	45	$10,000	$450,000				
1993	78	123	$1,500	$567,000	$15,000	$15,000	$15,500	$1,170,000
1994	40	163	$1,500	$627,000	$15,000	$15,000	$15,500	$2,990,000
1995	30	193	$1,500	$672,000	$15,000	$15,000	$15,500	$4,355,000
1996	0	193	$1,500	$672,000	$15,000	$15,000	$15,500	$4,355,000
1997	64	257	$0	$672,000	$15,000	$15,000	$15,500	$7,267,000
1998	100	357	$0	$672,000	$15,000	$15,000	$15,500	$11,817,000
1999	100	457	$0	$672,000	$15,000	$15,000	$15,500	$16,367,000
2000	100	557	$0	$672,000	$15,000	$15,000	$15,500	$20,917,000
2001	100	657	$0	$672,000	$15,000	$15,000	$15,500	$25,467,000
2002	100	757	$0	$672,000	$15,000	$15,000	$15,500	$30,017,000
2003	100	857	$0	$672,000	$15,000	$15,000	$15,500	$34,567,000

(Table B-14 continues across next page)

(Table B-14 continues across page)

	Performance verification		On-the-job training						
FY	PV Cost	Cumulative avoided cost	Reduction in years to FPL	Average OJT cost per year	Annual avoided cost	Cumulative avoided costs	Total cumulative avoided FAA costs	Cumulative MnATCTC Costs	Benefit to cost ratio
1991			0.07	$43,913	$3,074	$79,922	$339,922	$6,733,942	$0.05
1992			0.07	$43,913	$3,074	$138,326	$588,326	$8,750,499	$0.07
1993	$500	$39,000	0.07	$43,913	$3,074	$378,091	$2,115,091	$10,814,545	$0.20
1994	$500	$59,000	0.07	$43,913	$3,074	$501,047	$4,118,047	$10,839,271	$0.38
1995	$500	$74,000	0.07	$43,913	$3,074	$593,265	$5,620,265	$10,855,131	$0.52
1996	$500	$74,000	0.07	$43,913	$3,074	$593,265	$5,620,265	$11,123,686	$0.51
1997	$500	$106,000	0.07	$43,913	$3,074	$789,995	$8,728,995	$12,842,654	$0.68
1998	$500	$156,000	0.07	$43,913	$3,074	$1,097,386	$13,586,386	$14,361,623	$0.95
1999	$500	$206,000	0.07	$43,913	$3,074	$1,404,777	$18,443,777	$15,881,038	$1.16
2000	$500	$256,000	0.07	$43,913	$3,074	$1,712,168	$23,301,168	$17,400,453	$1.34
2001	$500	$306,000	0.07	$43,913	$3,074	$2,019,559	$28,158,559	$18,919,869	$1.49
2002	$500	$356,000	0.07	$43,913	$3,074	$2,326,950	$33,015,950	$20,439,284	$1.62
2003	$500	$406,000	0.07	$43,913	$3,074	$2,634,341	$37,873,341	$21,958,699	$1.72

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