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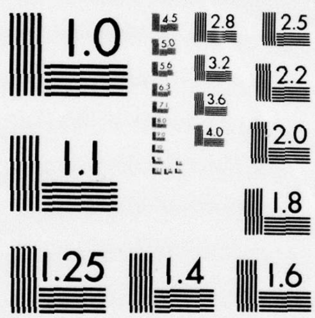

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Report No. FAA-RD-78-77

SURVEY OF RADAR SIMULATION TRAINING AT ATC FIELD FACILITIES

Stephen Karovic

Theodore Rundall

SEPTEMBER 1978

FINAL REPORT

Document is available to the U.S. public through the National Technical Information Service, Springfield, Virginia 22161.

Prepared for

U.S. DEPARTMENT OF TRANSPORTATION

FEDERAL AVIATION ADMINISTRATION

Systems Research & Development Service

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16. Abstract

The results of a system-wide review of the current air traffic control enroute and terminal radar simulation training capability are discussed. Teams of air traffic controllers from NAFEC and from the field, with engineering support, visited 10 en route air traffic control centers and 17 terminals equipped with Automated Radar Terminal Systems (ARTS III). Training personnel from three other ARTS III facilities were interviewed. It was found that the field simulation systems, although originally designed only as software checkout tools, now provide the field facilities with a radar training capability far surpassing that previously possible. However, despite the generally wide acceptance and acclaim given this new capability, shortcomings were uncovered which limit the training effectiveness and full utilization of the system. These shortcomings, including problems with equipment, software, staffing, etc., are identified and discussed. Specific recommendations are made for the purpose of enhancing air traffic control radar simulation training in field facilities, including software modifications, increased staffing, improved communications, and, in terminals, an increased number of displays.

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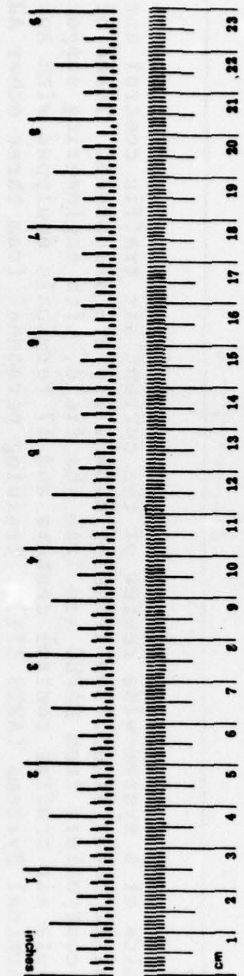
METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

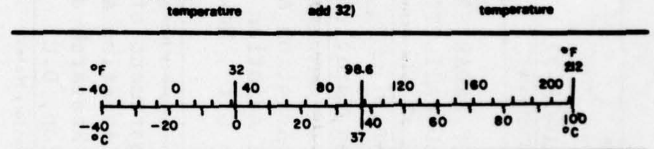
Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



PREFACE

The conduct of this study required the help and cooperation of several organizations and individuals. The authors gratefully acknowledge the special contribution of Messrs. Charlie Dudley and Lewis R. McClenahan, Data Systems Specialists from Baltimore Tower and Washington Air Route Traffic Control Center (ARTCC), respectively, who provided essential current facility experience during the surveys and valuable advice in the software analysis of results. They also prepared appendices C and D and the National Airspace System (NAS) Change Proposals for the suggested improvements resulting from the survey. The cooperation of the Eastern Region and the Baltimore Tower and Washington ARTCC facility chiefs in releasing Messrs. Dudley and McClenahan for work on this project is also especially appreciated. The authors are also indebted to Mr. Floyd Woodson, ANA-230, who acted as engineering consultant on the survey team, and to Mr. R. A. Bales of MITRE Corporation, METREK Division, who participated in the early portions of the data collection and provided additional insight. In addition, of course, the authors acknowledge the fine cooperation and assistance received from every regional office and from the facilities visited.

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INTRODUCTION

PURPOSE.

The National Aviation Facilities Experimental Center (NAFEC) conducted a survey of field facilities' radar simulation training programs. The purpose of the survey was to identify the capability, usage, and limitations of Dynamic Simulation (DYSIM) and Enhanced Target Generator (ETG) and to solicit and evaluate suggested enhancements to radar simulation.

BACKGROUND.

The Federal Aviation Administration (FAA) National Training Program for air traffic control specialists (ATCS) requires environmentally oriented radar training at air traffic control (ATC) facilities. This requirement is satisfied through the use of the DYSIM program of the National Airspace System (NAS) Enroute Automation System in air route traffic control centers (ARTCC's) and in the ETG program of the Automated Radar Terminal System (ARTS III). These programs were not originally designed for training, but rather as software checkout implements, and therefore have required modifications to make them suitable for training.

GUIDELINES.

The basic requirements for this effort were contained in an Engineering and Development Program Plan (reference 1). A specific request for a system-wide review of the field simulation capability was prepared by Air Traffic Services (ATS) (AAT-10 letter to ARD-100, dated September 9, 1976, "Engineering and Development Program Plan--Air Traffic Control Specialist Personnel Support" No. FAA-ED-21-3). The specific items to be investigated (listed below) were reiterated in guidelines received from a working group, consisting of representatives from AAT-14, APT-310, AAF-610, and ARD-152. Follow-on meetings provided further clarification of each of the six defined items as follows:

1. Compare the capability of DYSIM with the capability of ETG.

The purpose is to determine if some beneficial feature exists in one program (DYSIM or ETG) that should be included in both. This is not a requirement to provide a detailed side-by-side comparison of the two programs.

2. Determine to what extent DYSIM and ETG accommodate our training requirements.

For this, it will be necessary to identify those training requirements that DYSIM and ETG do accommodate, and those that they do not accommodate. "Training Requirements" are defined as the requirements stated in the Instructional Program Guides (IPG) (references 2 and 3) and in the Air Traffic Training Handbook (reference 4) as well as the special training NEEDS of each facility (which may be different than the "official" training requirements) including the number of developmentals and full performance level (FPL) controllers requiring training at each facility.

"ETG and DYSIM" are understood to mean the radar simulation facilities at each ARTS III terminal and at each ARTCC, including computer programs, hardware and laboratory space, and (to a lesser extent) staffing and other support.

3. Determine to what extent simulation is being utilized in the field.

The purpose of this is to ascertain how many, and which, facilities use the radar simulation training capability provided; the degree to which it is used; whether it is used for pass/fail; whether it is used to the extent required in the IPG; whether it is used for other purposes (i.e., research and development); and how much it is used. If it is "underutilized," ascertain why.

One byproduct of this task might be implementation of a utilization reporting system, for regular submission of reports to headquarters, preferably as part of an existing report.

4. Assess the results achieved thus far.

"Results" is interpreted to mean the reduction in total training time or in the on-the-job training (OJT) portion of radar control due to use of DYSIM/ ETG. But this may be too narrow an interpretation. Other "results" might be that radar simulation is a morale builder, a confidence builder, and a provider of a QUALITY of training that would not otherwise be available, because simulation can provide realistic experience in a variety of situations, (e.g., emergencies, special traffic situations (traps), controlled traffic densities, and other unusual situations rarely encountered in normal traffic).

Some questions to be considered would be: Is the DYSIM/ETG-trained controller a "better" controller than the non-DYSIM/ ETG-trained controller? Is he better sooner? Are there any objective measures of this? If not, how about subjective opinions? What would they be, and of what value are they?)

5. Qualitatively and quantitatively identify shortcomings.

The shortcomings could be desired functions that the computer programs don't perform, or don't perform well; logistics problems involved with generating simulation problems or scenarios; limitations of training simulation functions during peak traffic periods; controller and pilot position availability; communications in the training lab; lab space. Shortcomings will be discovered as a product of tasks 1, 2, and possibly 3, above. They will be reflected in NAS Change Proposals (NCP's) or elicited in discussions with regional or facility personnel.

6. Solicit and evaluate suggested improvements.

These improvements are viewed as applicable to any part of the radar simulation training activity. They may include recommended changes to software, revisions to the training requirements, equipment improvement, and exchanging and publicizing solutions developed by some facilities to problems being experienced at other facilities. Where appropriate, recommendations for improvements will be supported by statements of training effectiveness.

DEFINITION OF TERMS.

An explanation of some of the terms used in this report may help to avoid some common confusions.

Proficiency Training: Training conducted for the purpose of reinforcing previously learned skills and for developing new skills pertaining to new or revised procedures, regulations, equipment, etc., required to maintain operating position currency.

On-the-job training (OJT): Training conducted on positions of operation, under direct supervision, to prepare the specialist to demonstrate the ability to perform ATC duties.

Initial Training: The process of learning initial skills and knowledge leading to certification on positions/functions on which a specialist has not previously been qualified.

Subsequent Training: The process of requalifying on positions of operations. For instance, a specialist transferring from a visual flight rules (VFR) tower to a Terminal Radar Approach Control Facility (TRACON) would be considered in subsequent training in control tower cab duties and initial training in radar duties.

TECHNICAL APPROACH

A previous project (216-103-110, "Simulator Pilot Consoles for NAS Enroute and ARTS III facilities") (reference 5) required visits to a few ARTCC's and ARTS III-equipped terminals and contacts with a limited number of Evaluation and Proficiency Development Officers (EPDO's) and Staff (EPDS) personnel. As a result, some preliminary data, including a comparison of DYSIM and ETG, were accumulated. Additional general information on the status of the field simulation training systems and some of the problems involved was received from the EPDO and EPDS conferences held at the FAA Academy in January and February 1977.

Training documentations, including the IPG and Air Traffic Training Handbook, were obtained and reviewed. The computer program functional specifications (CPFS) defining the latest update of DYSIM and ETG functions were accumulated and reviewed (references 6 and 7). All available information on outstanding NCP's affecting DYSIM and ETG, not yet documented in the CPFS, was obtained.

Face-to-face discussions and the use of questionnaires and checklists were the primary methods used to collect data on the current status of DYSIM and ETG in the field. Visits to selected representative facilities in the various regions with different levels of complexity were made to obtain data and to familiarize the study teams with the operation of the system. At each facility, the teams observed training in progress, if any, and discussed the facility's training experiences, requirements, and plans with facility personnel. Specific questions were used to elicit responses for each of the items listed in the guidelines above (appendix A). Equally important, a conscious effort was made to generate new questions. Information obtained in early interviews was used to modify subsequent interviews.

The radar training laboratory environment and equipment was observed, discussed with system engineers or technicians responsible, and compared with other such facilities.

The personnel conducting this survey consisted of two air traffic control specialists and one electronics engineer from NAFEC, and two Data Systems Specialists (DSS) detailed from the Eastern Region. A list of the facilities visited during the survey is contained in appendix B.

In performing the evaluation of the status of DYSIM and ETG, the survey team relied heavily on the experience and the candor of the people they visited and talked with at the facilities. This report is based on what facility personnel told the team members about their facility--the accomplishments they achieved and the problems they encountered. In all, the survey covered

30 facilities--10 centers and 20 terminals. The data collected and contained in this report consist of some hard facts, some estimates, some judgments, and some opinions. Each of the items defined in the Guidelines (except item 1) is covered in a separate section of the report. A detailed comparison of ETG and DYSIM (item 1) is contained in a previous NAFEC report (reference 5).

The conclusions and recommendations reflect entirely the team's own judgments based on what was learned during discussions with the training staffs and the data systems staffs at the centers and terminals.

OVERVIEW

In almost all cases, the training and data systems personnel interviewed showed genuine enthusiasm for simulation training and were eager to further develop its potential. Personnel from all facilities are enthusiastic about their simulation capability and feel that it is the most important training tool they have ever had.

It became immediately apparent that the facilities visited differed in many aspects of simulation training. Some had been conducting a fully implemented, although still evolving, simulation training program for over a year, while others had barely reached the planning stages. Some were vigorously pursuing the program, while others were moving agonizingly slowly with it. It also became apparent that we were dealing with a mixture of diverse elements consisting of automation and its companion hardware and software; orders (national, regional, and local) pertaining to automation, to training, and to staffing; organizational structures; and above all, people--ATCS's, EPDS's, DSS's, Airways Facilities Service personnel, chiefs, deputy chiefs, program officers, regional office operations, and automation specialists--and these are, of course, the very same elements that comprise our ATC system. Within this complex, we tried to discover a unified training program at work. We found that there was such a program, and that simulation training, generally, was being conducted along the guidelines provided for that program. Variations in all of the above elements constantly confronted us, however, making the thread of unity appear to be tenuous at times. The following common elements were found that tend to tie the facilities together into a unified, national training program:

1. All facilities have a training staff.

2. All facilities that use DYSIM and ETG follow, at least basically, the guidelines provided by the IPG and the Problem Development and Administration Guide.

3. All facilities use standard equipment; plan view displays (PVD's) in centers and data entry and display systems (DEDS's) in terminals for controller positions and for pilot positions.

4. The DYSIM and ETG software used at centers and terminals is, with isolated variations, similar at each facility.

The basic concept being followed in DYSIM and ETG is, of course, one of generating simulated targets and allowing trainees, using an operational radar console (in training status), to issue ATC instructions to the pseudopilots, who, through use of the operational keyboard, cause the target to comply with the trainee's instructions. There are almost as many variations in how the simulations are conducted as there are facilities. Consider the variety of ways, for example, that new role-playing of pseudopilot, controller, and instructor is accomplished. Some of the following role-playing devices are employed because of necessity (lack of pilot positions or shortage of pseudopilots). Other methods have evolved at the various facilities as simply the best way, as they see it, of accomplishing the training task.

Method 1: Two pilots, one instructor, one pilot controls even-numbered targets, the other odd-numbered targets. Each provides voice response for his own targets. Instructor ghosts intercom responses.

Method 2: Two pilots, one instructor, as above, but instructor provides all voice responses.

Method 3: One pilot, one instructor, as in method 1.

Method 4: One pilot, one instructor, as in method 2.

Method 5: One pilot, instructor is pilot <u>and</u> instructor. He provides all voice responses.

Method 6: Three pilots, one instructor, each pilot provides voice responses for the flights he is controlling. Instructor handles interphone.

If, as is often the case in terminals, no interphone or communications system is used, all of the above positions (pilots and instructor) are clustered around the controller being trained, and everyone talks "into thin air." Under these conditions, of course, everyone can hear everyone else. This unrealistically inhibits the pilot from saying anything while the controller is on "interphone" and inhibits the "interphone" user from initiating a call while "radio" communications are in progress.

In some terminal facilities and in all enroute facilities, pilots work from a separate display. Under these circumstances, some sort of a communications system is provided to allow pilot/controller communications. These communications systems range from (1) simple homemade lines (often fabricated by facility AFS personnel) to (2) systems that simulate, but do not duplicate, radio and interphone lines, to (3) actual extensions of the facility's Bell 301A systems.

Figures 1 through 13 illustrate some of the physical layouts that were observed during the survey.

ACCOMMODATING REQUIREMENTS

GENERAL.

The guidelines defined ETG and DYSIM as radar simulation systems comprised of data processing equipment, software, laboratory space, and staffing, rather than treating it in the narrower sense of simply a computer program. The guidelines define radar simulation training requirements rather broadly. These are the requirements stated in the Instructional Program Guide (reference 3), the Radar Problem Developments and Administration Guide (reference 8), the Air Traffic Training Handbook (reference 4), and the special training needs of each facility, which may be different than the "official" training requirements.

Even with the terms defined, we felt it necessary to subdivide the question, because, we reasoned, if all the ETG or DYSIM resources of a facility were devoted to training one individual, we could determine to what extent ETG or DYSIM can accommodate the training requirements qualitatively. If, however, these same resources are spread out among the entire ATCS facility complement, the results (i.e., the extent to which training requirements are accommodated), would be quite different. In this case, we would be dealing with the quantity of training DYSIM and ETG can provide.

ENHANCED TARGET GENERATOR

For the qualitative determination of ETG's ability to meet the training requirements, we can first compare the functional capabilities of a basic, dedicated ETG package (one DEDS with three keyboards) with the training requirements themselves.

The Terminal Radar Problem Development and Administration Guide, TI-V-0 (reference 9), was issued for use at ARTS III facilities. This publication is intended to provide the guidance its title suggests, and because of the variables known to exist at individual terminal facilities, allows for rather broad interpretation and tailoring of much of its contents to the needs of the individual facility.

With some exceptions, the training requirements for Part I Basic Radar Requirements (TI-V-0) can be met successfully by ETG. One exception is in lesson 2, exercise 1 (page 7), where the objective is stated "Radar identify aircraft by the use of primary and secondary radar identification methods." Part of this exercise can be accomplished (i.e., the controller can issue appropriate beacon change instructions), but the display of primary and secondary targets cannot now be duplicated using ETG because ARTS III symbology does not include representations of primary and secondary (broadband) radar targets. For generally the same reasons, training requirements described in the advanced section of TI-V-0, lessons 3, 4, 5, 9, and 10, can be accommodated to only a limited extent.

TI-V-0 *states that* ETG training will be conducted on a pass/fail basis, yet it has been criticized because it does not provide precise criteria for pass/fail situations. (The enroute guide is much more exact in this respect.)

The same training manual, TI-V-0, states "The Enhanced Target Generator Radar Training (ETG) course gives the specialist an opportunity to learn and demonstrate, under simulated conditions, all the knowledge and skills required of a full performance controller." The basic ETG package (one display and three keyboards) cannot, in fact, provide "all the knowledge and skills required of a full performance controller." This may appear to be fault-finding over editorial language, but such is not the case. It is indeed highly desirable to have as a goal for the simulation system what this document claims for it. While the basic ETG package can and does meet many of the training requirements that eventually lead to "all the knowledge and skills required of a full performance controller," it falls short not only in areas such as primary and secondary radar presentations--it falls short of broader goals that should be, but are not, described as requirements.

These unstated requirements involve meaningful training in the skills of coordination, communications, and interaction. The performance of radar control in the real world is interlaced with these equally essential tasks, but the ETG package does not include a communications capability, nor does the ETG training literature recognize any requirement at all for training in interaction between radar positions. These tasks are vital in training because they are vital operationally. Support for the need of such training is evidenced by controllers who "pass" ETG training but who wash out later in OJT because of the added burden of communications, coordination, and interaction they are faced with in the real world.

It is obvious to all its users that much of the contents of TI-V-0 have become obsolete. For example, since its publication, the maximum number of ETG targets has been increased from 32 to 64, the target identifiers have been changed from alphas and numerals to all numerals and, most importantly, only manually entered problems, rather than scenario tape inputs, are dealt with. TI-V-0 needs to be updated, and probably will need to be updated frequently in the future.

It seems to the survey team that inclusion of a precise national pass/fail criterion at the time that TI-V-0 was originally issued would have been premature. As experience with ETG is gained in field facilities, national pass/fail criterion should be established, based on that experience. The criterion should, as it has in the past, assure overall uniformity while allowing field facilities to meet their specific and individual needs within its guidelines.

On the positive side, ETG has shown its potential to be an excellent method for teaching radar control in vectoring, spacing, providing assistance, handling arrivals, departures, overflights, both instrument flight rules (IFR) and VFR under various wind, and, to a less graphically realistic extent, weather conditions. ETG has been proven to be excellent for learning phraseology and for reinforcing the learning of geographic areas, airspace boundaries, obstructions, and emergency procedures. These positive findings are much more in evidence at those facilities where two displays are in use (one for the pilots and one for the trainee) and where adequate staffing has been provided.

The quantitative determination of the extent to which ETG accommodates the training function can be described as the balance between demand and supply. The demand is determined by the training load of a facility (hours of ETG training required), and the supply is determined by the resources available to satisfy that demand (staffing, equipment, and software). As previously noted in examining almost any aspect of ETG training, we were confronted with variable and changing conditions from one facility to the next. Even while the survey was in progress, new training requirements were formulated, and at the same time implementation of the ETG program was picking up momentum. With these variable and changing conditions in mind, it can be stated that the quantity of ETG training being provided did not meet the training requirements at most facilities visited. The major reason for this, as felt by the people interviewed, was insufficient staffing. The training load and the resources available are treated in detail in subsequent sections of this report.

In summary, it can be stated that the extent to which ETG actually does accommodate training requirements varies widely from facility to facility; completely failing to accommodate the training requirements at some facilities, succeeding rather well at others, and lying somewhere in between these two extremes at the rest. The success with which ETG training has been accomplished at some facilities shows that ETG has the potential to accommodate the training requirements to a high degree. It is also apparent that a facility that has an inadequate number of EPDS's cannot have an adequate training program. The exception to this statement is that some outstanding individual EPDS's performed above and beyond what could reasonably be expected of them and thereby forced the ETG program into being at their facilities. It was also noted that equipment and its deployment at each facility has a decided impact on the success of that facility's ETG program.

DYNAMIC SIMULATION.

DYSIM is rapidly being recognized at all levels as the best training aid ever available for enroute controllers. It is a constantly improving training tool and it is, therefore, difficult to determine the extent to which it accommodates the requirements of the national training plan at any one point in time.

Training requirements also are changing with more emphasis on the utilization of simulation. As more demands are placed upon the system, improvements to the efficiency, realism, and staffing are necessary to meet the requirements.

It is difficult or unrealistic, at present, for DYSIM to accommodate the training requirements for the training in broadband in case of a narrowband failure, the control of a breakup of a formation flight, the control of aircraft in relation to weather, and for the standardization of training due to presence of actual upper winds.

Training requirements placed on facilities do not make provision for the staffing to carry them out. Simulation training is only one portion of the total training program, and most facilities have one, or at best two instructors more or less permanently assigned to simulation. Present requirements mandate expansion from an 8-hour-per-day, 5-day-per-week operation to at least a two-shift operation at some, if not most, facilities. Facilities that have fewer developmentals can meet the requirements with fewer weekly hours. The present EPDS staffing at most facilities is insufficient to support such a program. In summary, the staffing provided to support DYSIM does not accommodate the training requirements.

Another and perhaps the most important area to assess whether DYSIM accommodates training requirements is the degree to which it is affected by operations. The training at most facilities is adversely affected by operational requirements. This is in both personnel and computer capacity. Frequently, on the busier days or when the weather deteriorates, personnel to support training are needed operationally, and a slowdown in computer response times is occasionally experienced. When this occurs, the DYSIM program is terminated to insure operational integrity. A reporting system of DYSIM terminations that would provide the ability to recognize a possible tendency of system saturation is lacking. DYSIM cannot accommodate training requirements if the incidence of DYSIM shutdown increases. At present, this is an occasional and undocumented occurrence, but an increasing trend has been noticed.

UTILIZATION

GENERAL.

As stated in the guidelines, information regarding utilization of ETG and DYSIM was solicited in terms of how many hours per week ETG and DYSIM are used, the purposes for which they are used, whether they are used for pass/fail, and what, if any, problems are associated with utilization.

The amount of utilization and the purpose for which they are utilized appears to vary significantly among facilities, based on the facility's needs, its capacity to meet these needs, and the priority given to training from support organizations.

The utilization of simulation in facilities has been increasing steadily since its inauguration. This increase, however, has not been parallel in all facilities. New and dynamic programs, such as DYSIM and ETG require frequent communications among its users and uniform support from management to more fully realize their potential. Though the training required at a particular facility may be more complex than at another, the training itself is of uniform importance. In any case, in most facilities there is little, if any, documentation to accurately measure the amount of utilization being achieved.

At the present time for example, there is little documentation which verifies that an estimate of DYSIM training lost at some facilities is up to 40 percent of prime training time due to computer response time slowdown. Since staffing limitations usually preclude developmental training during off hours, this figure represents a significant reduction of available DYSIM utilization.

It was discovered that facilities in Eastern and New England regions maintain records of ETG and DYSIM utilization, with New England region by chance having started their record-keeping at about the time this field survey was begun. Records of ETG and DYSIM utilization at facilties in other regions were found to be nonexistent or incomplete. Even where records are kept, the data are difficult to interpret and do not lend to comparison. It was found, for example, that the "training man-hours" recorded at one facility do not equate to hours of simulation usage. Nor does "ETG time" at a facility that sometimes trains two controllers simultaneously equate to "ETG time" at a facility that trains one at a time.

Problems in determining actual utilization were recognized during the survey period and were brought to the attention of ATS with recommendations for implementing a uniform method of reporting planned and actual utilization of ETG and DYSIM.

ENHANCED TARGET GENERATOR.

AMOUNT OF USE. Records and estimates of ETG utilization that were provided during the survey indicate that utilization at level III facilities ranged from 2 hours per week to 27 hours per week. At level IV facilities, utilization ranged from 1 to 80 hours per week. At level V facilities, utilization ranged from 2 to 112 hours per week. Even these figures cannot be accepted at face value, however, because the higher range values were based on statements such as "16 hours per day, 5 days per week" when in fact these are maximum utilization figures rather than sustained hours of utilization. The varibilities in the sources and in the accuracy of the data available make it impractical to apply statistical methods in its analysis. A subjective view of the information reveals the following factors, however:

1. Actual overall utilization could not be determined.

2. Utilization varies widely from facility to facility.

3. Utilization fluctuates within most facilities, depending on the number of developmentals in the radar training phase at any particular time, and on the time of year. (Summer vacation schedules, for example, have a decided impact on training.)

4. The median utilization (which appears to be the most reliable of the figures) appears to be around 13 to 17 hours per week.

5. The ETG program is just beginning to be implemented at some facilities, and its use is increasing steadily at many other facilities.

6. The number of controllers who have completed initial, subsequent or proficiency ETG training (at the time the facility was visited) was: at 5 facilities, none; at 2 facilities, one; at 1 facility, 9; at 3 facilities, between 11 and 30; and at 9 facilities, more than 30.

Low utilization of ETG was most often attributed to a too small training staff. Nonavailability of displays was also cited as a reason for low utilization. Also, it appeared to the survey team that at some locations the training staff simply did not know where to begin in ETG or how to work its way around problems that had become stumbling blocks. At some facilities, it was noted that little data systems support was provided to the training staff. At one facility, the data systems staff merely passed on Site Program Bulletin Six to the EPDS and left him "on his own." One ingredient that was obvious at all but one of the facilities with highly successful ETG training programs was a close partnership between the data system's staff and the training staff in getting the ETG program up to speed and keeping it there. These and related causes of low utilization are described in detail in the section of this report that deals with "Shortcomings."

PURPOSES. The following tabulation indicates the purposes for which ETG has been used at the facilities surveyed:

Qualification training:
(For developmentals and transferred FPL's, including surveillance approach qualification.)

Basic ARTS III indoctrination:
(Keyboard entries, display functions, adjustments, and alignment.)

Profile descent:
(Familiarization and practice with profile descent techniques and problems. Development of procedures and airspace delegations.)

Training in new procedures:
(Revised arrival/departure procedures and airspace responsibilities. Resectorization. Airspace delegation. Introduction to minimum safe altitude warning (MSAW).)

Training in use of tower BRITE display and crosstraining for local controllers (tower cab):
(Tower controllers at Fort Lauderdale, Opalocka, and Tamiami were trained at Miami. Los Angeles International and O'Hare tower controllers received similar training with ETG.)

Technical Appraisal Program (TAP):
(San Antonio and Dulles conduct part of their TAP appraisals using ETG.)

Radar training for adjacent regional approach control facilities:
(Facilities acquiring radar for the first time receive initial radar training at an ARTS III facility within their region. Boston-trained controllers from Portland, Bangor, and Otis. O'Hare-trained controllers from Rockford.)

High-density traffic situations:
(Fly-ins, conventions, military exercises.)

Proficiency training:
(Includes training for unusual situations and refresher training.)

Remedial training:
(Actual and potential systems errors are simulated for briefing and training purposes.)

Unusual traffic flow configuration:
(For example: Oakland - Southeast configuration; Houston - Runway 32 flow.)

Parallel instrument landing system (ILS):
(Detroit, Dulles, and Miami.)

Noise abatement

Takeover of Tacoma Radar Approach Control (RAPCON) area

Other:
(Briefing aviation groups, flight crew briefings. ARTS III baseline testing, program development, and program checkout performed.)

PASS/FAIL. None of the terminals use pass/fail in the way prescribed for centers. Fifteen of the facilities surveyed do not consider themselves well enough equipped, staffed, or experienced to use pass/fail at all, and many of them feel that the criteria for pass/fail are not adequately defined in the ETG training literature. The remaining five (O'Hare, Miami, Houston, Philadelphia, and Jacksonville) stated that, in effect, every controller must satisfactorily complete an appropriate series of ETG problems before he continues with related sessions of OJT.

When facilities that did not use ETG on a pass/fail basis were asked why they did not, the answer usually was that they did not have a realistic enough simulation environment, that they were not far enough advanced with the ETG program, and that there were insufficient guidelines in TI-V-0 (reference 8). On the other hand, facilities that were using ETG as a pass/fail determinant (i.e., those that have a satisfactory environment and sufficient experience with the program) did not have a problem with guidelines. Each of these facilities has its own criterion, even if undocumented, and it seems to work well for them. Their very reasonable philosophy is that if a trainee cannot do a satisfactory job in the ETG laboratory, he will not be permitted to attempt to do so with live traffic.

DYNAMIC SIMULATION.

AMOUNT OF USE. The extent to which DYSIM is being utilized varies significantly among the facilities. This is attributed to a number of causes. Among them are:

1. The number of developmentals to train.

2. Staffing shortages in the EPDS staff or the full performance level (FPL) controller complement.

3. DYSIM shutdown due to computer response time slowdown.

The prime training time is during weekday administrative hours, since the training staff generally does not work on evenings or weekends because of staffing shortages. This is, however, the same time that computer and manpower demands are probably the highest, since it encompasses most of the hours that historically are the busiest operationally.

An estimate of DYSIM usage, based on very sketchy information, among the 10 ARTCC's visited would fall in the range of from less than 10 hours per week up to 72 hours per week. In most facilities, DYSIM usage is curtailed during the Christmas and summer seasons, so that it is used for 9 months from September 1 to June 1 excluding a couple of weeks for Christmas. This in itself represents a 25-percent yearly nonusage. An estimate of best case yearly utilization is 28 percent (205 days/12 hours per day). (This is 2,460 hours per year out of a possible 8,760.)

This 28-percent utilization is perhaps not as bad as it sounds, since a 100-percent utilization is not really practicable. In fact, if an average of 5 days per week, 12 hours per day could be maintained for 52 weeks of the year, it would be a yearly usage of only 36 percent. This, then, might be optimum utilization, and the best case, 28 percent, is not too far out of range. It should, however, be remembered that the 28-percent figure represents only 1 of the 10 facilities and is far above the estimated utilization of the others. There are too few records available to depict the total number of people trained by the use of DYSIM. The developmental program is somewhat documented; however, training accomplished during evening or weekend hours when the training staff is off is for the most part not recorded at all.

PURPOSES. DYSIM is utilized, or anticipated to be utilized, for a number of purposes. Most facilities, at one time or another, have used it for the following:

1. Training developmentals

2. Refresher training

3. Remedial training

4. Resectorization training and development

5. High/Low sector crosstraining

6. Training for unusual situations

7. Technical performance appraisals

8. Requalification training

9. Transferred incoming FPL training

10. Profile descent training

11. Flow controller/team supervisor DYSIM exposure

12. Developing and testing software patches

Here again, in most cases, there is little documentation available to determine the amount of time devoted to any specific use.

PASS/FAIL. Pass/fail training as prescribed by the National Training Plan (references 8 and 9) is being accomplished at 7 of the 10 facilities visited. An additional two facilities plan on inaugurating pass/fail testing as soon as developmentals in the pipeline reach Phase XI training. The 10th facility is using DYSIM for pass/fail with some modification to the National Program, in that evaluations are performed and weaknesses identified for concentrated training, but pass/fail determination is reserved until all problems have been taken. This facility has an enthusiastic, innovative staff and is well supported at the regional and facility level. The training staff has developed a complete training program and is constantly looking for ways to train more effectively and efficiently. Perhaps the most interesting aspect of this facility's training program is that emphasis is placed on helping the student learn rather than on testing of abilities. In other words, teaching is the primary concern, and testing is a measurement of the student's ability to learn as well as the instructor's ability to teach. In some programs, it appears that testing is paramount and instruction is geared to teaching to pass the tests rather than teaching to help the student learn.

The pass/fail program is a beneficial screening device and should be retained. The way that pass/fail is applied, however, should be reexamined to determine if it is effective and efficient.

The total number of developmentals that went through pass/fail DYSIM testing in the 10 facilities visited is 242. The total number of DYSIM failures is 22. Two facilities have not, as yet, had any developmentals through pass/fail tests using DYSIM. The average failure rate for the eight facilities having had pass/fail DYSIM testing is 9.09 percent. Individual facility failure rate varies from 0 to 22 percent as shown in table 1.

RESULTS ACHIEVED

Training staffs at centers and terminals were asked to provide information that could help us assess the results that have been achieved thus far with simulation training. In addition to a reduction in OJT from the use of DYSIM and ETG, as requested in the guidelines, the training staffs were questioned about other more abstract results such as effects on morale, confidence, workload, and quality of training.

ENHANCED TARGET GENERATOR.

When training staffs were asked about results achieved, each of those that have used simulation training told us of one or more benefits that have been effected through the use of ETG.

TABLE 1. FAILURE RATE PER FACILITY

Facility	DYSIM Students	Failures	Failure Rate Percent
Boston	0	0	0
Seattle	0	0	0
Los Angeles	6	0	0
Kansas City	9	2	22
Denver	11	0	0
Oakland	12	2	16.7
Washington	19	3	15.8
Miami	50	5	10
Houston	55	1	1.82
Chicago	80	9	11

Little objective data are available to support these claims, but the conviction with which the results were described leaves no doubt that the benefits of ETG are real and significant.

The one area of results that most readily lends itself to analysis is the claim that simulation training reduces the amount of OJT required. Preliminary data provided by Dallas -Fort Worth TRACON indicate a reduction in OJT of slightly over 50 percent since ETG was introduced. Records kept at the Houston TRACON indicate a reduction in OJT of 43 percent since ETG training was implemented. The Houston staff believes that about a 25-percent reduction in OJT is directly attributable to the benefits of ETG, with most of the remaining reduction probably due to improved selection and recruiting. Other facilities estimate reductions in OJT of 20 to 50 percent, with expectations of even greater reductions as experience is gained and improvements made to the program. One facility that uses ETG stated that no decrease in OJT has been noted, but this is definitely an exception. Benefits resulting from the use of ETG, as cited by training staffs, are listed below:

Reduced OJT Time. This has significant implications for safety, economy, and efficiency. Less time in training status means money saved by producing an FPL controller sooner. One facility estimated that optimally reduced OJT (50-percent reduction) could save $235,000 per year at that facility, with a turnover rate of 20 controllers per year. Shortening the OJT period reduces the risk of the trainee making mistakes while working live traffic.

Weaknesses can be identified and corrected by simulating appropriate traffic situations.

Phraseology is improved.

Learning complex airspace is facilitated by learning in a dynamic situation.

The trainee is better prepared to deal with unusual situations and emergencies

Morale and confidence are improved.

Learning local procedures and letters of agreement are reinforced

Stress on the trainee and workload on the instructor are reduced.

Systems' errors are reduced. By implication, remedial training and proficiency training and the use of "conflict scenarios" (re-creating actual or potential systems' errors on scenario tape) contribute to a reduction in systems' errors.

Separation standards can be graphically demonstrated.

Attitudes toward training are improved throughout the entire facility.

New procedures, such as profile descent, and revised terminal traffic flows, such as experienced at Baltimore, Houston, and St. Louis, are more efficiently developed and prepared for.

Proficiency training can be accomplished in seldom used traffic flows and traffic conditions, such as the southeast flow in the Oakland Bay area; runway 32 configurations at Houston Intercontinental; parallel ILS approaches at Dulles, Detroit, and Miami; two-feeder final approach at Oakland; and sporadic traffic flurries.

All the training performed with ETG does not have positive results. Some "negative training"--things that must be "unlearned" after simulation training has been completed--has been reported. The negative training is involved with the two shortcomings listed below:

1. Implied keyboard functions in the operational program are not implied in ETG.

2. The mechanics of communications used operationally, such as buttonpushing, the use of headsets, mike switches, and headset/loudspeaker switching, etc., are not experienced in ETG training. Whatever communications habits were learned in ETG must be replaced by new habits during OJT.

DYNAMIC SIMULATION.

Most enroute facilities feel that they have not had enough exposure to judge the results achieved by the use of DYSIM. Personnel at all facilities are enthusiastic about the DYSIM program and feel that it is the most important training tool they have ever had.

The enroute facilities that were able to provide statistical data or estimates indicate a 40- to 60-percent decrease in OJT time for DYSIM graduates. There is also an indication of a trend towards a larger decrease in OJT the longer DYSIM is utilized. For example, one facility reported a decrease of 12 percent in OJT with the first DYSIM class, a decrease of 23 percent with the second class, and a decrease of 60 percent with the third.

Although the potential decrease in OJT hours is impressive, perhaps the most beneficial results are in areas more difficult to measure. DYSIM is recognized as a training aid that provides a better quality of training. It provides for realistic training in a simulated environment. As such, it reduces the stress of training in the live environment. The student and the OJT instructor have more confidence in the student's ability. The OJT instructor is provided with prior knowledge of the student's strengths and weaknesses and also can now provide a higher quality of training. Students with little or no potential have been screened through the pass/fail concept in simulation rather than in the live environment.

Whether a DYSIM-trained controller is a better controller than one trained without DYSIM is perhaps a moot point. However, that the training is more professional and less trauatic is obvious.

Benefits mentioned by facilities resulting from the use of DYSIM are as follows:

1. Makes situations available that are rarely encountered operationally.

2. Takes the most hazardous training out of the live environment (i.e., mistakes are made in training instead of in operational environment).

3. Helps to organize priorities.

4. Helps in teaching phraseology.

5. Builds morale and confidence.

6. Helps Team Supervisors identify weaknesses.

7. Reduces pressure on OJT instructor.

8. Reduces student apprehension of OJT.

9. Eliminates the weakest students prior to working live traffic.

10. Provides qualified controllers quicker.

SHORTCOMINGS

Both terminal and enroute facilities are faced with shortcomings in their simulation training programs. Many of them have been mentioned in previous discussions. Suggestions for their resolution are contained in subsequent sections of this report.

DISSEMINATION OF INFORMATION.

Simulation training at centers and terminals is still in an early stage of development. Training staffs are independently learning to implement ETG and DYSIM training, gaining little benefit from the same trial and error experiences and, eventually, the discoveries, made earlier by a training staff in another facility. As the program matures, the best ideas and methods are slowly being disseminated. It is true that each facility, particularly each terminal facility, is somewhat different from the others, and what is useful at one may not have application at another. But there are many problems in common that would have usable common "best" solutions. A few examples will make this clearer:

1. Jacksonville Tower EPDS and DSS staffs worked very hard to develop a Tactical Air Navigation (TACAN) approach, involving flying an arc and also methods of simulating formation flights and their breakup into individual flights. This is a routine part of their operation and therefore essential to their training program. Other facilities that handle military traffic are facing the same problem. The EPDS and DSS staffs at each one will spend time and effort and repeat the same mistakes and finally correct them independently.

2. Several terminals visited did not realize that scenario inputs could be directed to a phantom (nonexistent) keyboard (where only two keyboards are provided), thus removing a problem of interference with manual keyboard entries.

3. A technique of selectively speeding up the scenario entry of flights and thereby greatly enhancing the versatility of any scenario problem was developed at Houston, but this technique is not well known outside of the Southwest Region.

4. Flight strip printing via the Automatic Send/Receive (ASR-37) teletype is being used in one region for ETG problems. Flight strip printing by an adjacent center is accomplished at a few locations. Flight strip printing by assembly sites is being done in some instances. Yet, flight strips are tediously prepared manually at many terminal facilities.

All this points to the lack of a method of dissemination of "state of the art" information. This vacuum appears to be particularly unfortunate in the case of a burgeoning program such as simulation training.

At each facility visited, the EPDS staff recommended some type of national information exchange. The preferred method was national EPDS workshops (DYSIM and ETG) where problems, ideas, and solutions could be discussed on a face-to-face basis.

In addition to an exchange of information among the users, it is also necessary for persons responsible for the management of training programs to be cognizant of the utilization, resources needed, problems, and accomplishments of DYSIM.

Some method of continual measurement is needed to gauge DYSIM and ETG usage and effectiveness. There are no records available which accurately delineate the purposes for which they were used, the number of student training hours accomplished, the total support personnel hours to accomplish the training, and the reason and number of hours of DYSIM and ETG lost due to operational needs. These needs may be in man-power or in hardware/software.

With documentation provided by proper record-keeping, problems could be identified promptly, and action taken from a knowledgeable position to rectify the problem. Additionally, it would provide interested parties with current information on which to base other training decisions. This continuity of information is necessary in a dynamic, changing environment.

PROGRAM MODIFICATION.

One of the difficulties in enhancing field simulation capability exists in the NCP approval system (reference 10) whereby a few facilities, by not concurring with a proposed software modification, can keep it out of the national program. This is particularly puzzling in cases where the modification incorporates a choice of usage or nonusage, such as an additional climb rate or turn rate that can be used if desired but need not be used. Perhaps this attitude is merely a lack of understanding of the proposed modification.

The need for information exchange discussed above extends to the NCP process also, because it was claimed that the persons programing an approved modification seldom communicate with the originator to verify intent or interpretation.

Order 6120.1, "Field Participation in Discrete Operational Program Modifications" (reference 11), imposes a five-patch limitation for local program modifications. Guidelines are needed to lessen the wide gap of regional and/or facility interpretation of this limitation.

For instance, some facilities would like to incorporate the Seattle 117C patch, which contains several enhancements, but cannot, because all of the five patches are being utilized for operational modifications. Apparently some facilities interpret each modification as a patch, while others combine several modifications into each patch. This disparity in interpretation results in many facilities being deprived of the advantage of some highly beneficial improvements to the simulation systems. A clearer and more liberal interpretation of these rules is needed, and perhaps the limitations imposed by the rules should be reexamined to determine their validity.

There is a definite need to incorporate the most widely utilized modifications into the national program in a timely manner so as to release local patches for local usage.

ENHANCED TARGET GENERATOR.

STAFFING.

Requirements. The amount of training required, or the training load, at a facility determines the staffing required to support and administer it and also determines the number of controller displays and pilot displays required in the ETG lab.

The magnitude of work required at any ARTS III facility to adequately support ETG training may not be fully appreciated at organizational levels above the facility level. Many hours are needed to develop and document each ETG training problem. Some facilities have reported that it takes one man 1 week to develop and document one ETG training problem. Often, when the scenario tape is finally delivered and tested, minor flaws are discovered which must be corrected. Also, because ETG training problems have a way of becoming obsolete due to procedural changes at the facility and because improvements to training problems can always be envisioned, the process of developing scenarios is repeated rather frequently.

If the training load of a facility requires the lab to be operated 5 days per week, 8 hours per day, then a full-time EPDS is needed for that purpose alone. While team supervisors can, and should, be called upon to administer a certain amount of ETG training, their other duties preclude them from providing more than a small proportion of the scheduled and structured training required. Few of the facilities visited enjoy the luxury of being able to devote one EPDS full time to the ETG lab.

Determination of the training load of any facility must take into account the controller complement, the structure of that controller complement (FPL's versus trainees), and the complexity of the facility's operation. The types of training being dealt with in ETG are "Initial," "Subsequent," and "Proficiency" training. "Initial" training is required for controllers who have had no previous radar experience. "Subsequent" training is required for radar-experienced controllers who transfer from one radar facility to another. "Proficiency" training is required for all FPL's and first-line supervisors.

"Initial" training may require an average of 120 hours of ETG training for each controller, and "Subsequent" training may take an average of 60 hours. The actual number of training hours required per individual varies, depending on the ability of the trainee, the complexity of the facility's operation, and the degree of reduction in OJT that is being aimed for. "Proficiency" training is a fairly constant number of required hours, expected to total in the neighborhood of 20 hours of ETG training per year for each FPL controller and first-line supervisor.

Nearly every facility visited claimed that training staffs are either too small to properly support ETG or too small to support ETG at all. Some level-three facilities have only one EPDS to take care of the entire facility. At level-three facilities with more than one EPDS, there are constant call-backs to the floor for operational position coverage. This, coupled with the variety of collateral duties that EPDS's at all facilities are required to perform, seriously reduces the amount of time they can devote to ETG training. At the same time, level-three facilities traditionally carry the burden of training controllers who have no radar experience and who, therefore, require significantly more training.

Administering ETG training problems requires the presence of an EPDS or a team supervisor in the lab. His presence is felt to be necessary in order to achieve professional results. Without an instructor, the controller could merely be reinforcing poor control techniques and undesirable habits through practice. Some facilities are forced, because of inadequate training staffs, to allow proficiency training to be performed without supervision. It is reported that under these circumstances, bad habits may not only go uncorrected, but that "group dynamics" resulting from a particular combination of individuals determines, at random, the kind of training sessions that takes place.

The number of training hours that an ETG laboratory, training one controller at a time, is capable of producing in 1 day has been estimated at approximately five, assuming that one EPDS is available to spend his full time in the lab. (This is a realistic estimate of the number of productive hours of ETG training that can be accomplished in an 8-hour day, considering time necessary for briefing, running the problems, debriefing, lunch breaks, etc.) If the lab is productive 5 days per week, 48 weeks per year, then 1,200 hours per year of training can be accomplished during the administrative work week. It is estimated that an additional 600 hours per year of ETG training can be accomplished on weekends and second shift administered by team supervisors, yielding a total of 1,800 hours of training per year. If this does not satisfy a facility's requirements, then a second EPDS will be required, spending his full time in the ETG lab on the second shift. This can provide a total capacity of 2,400 hours per year (10 hours per day, 5 days per week, 48 weeks per year). Team supervisors may administer an additional 400 hours per year of ETG training on weekends, bringing the total number of training hours per year to 2,800.

If this does not satisfy the requirements for a particular facility, then more equipment (controller displays and pilot displays) will be needed so that more than one controller can be trained at a time. Additional staffing will, of course, also be required.

Pseudopilots. Another aspect of staffing shortcomings arises with the question of who performs the functions of pseudopilot. At most facilities, ETG training is administered to groups of three trainees who rotate through the two pilot positions and the one controller position. If trainees are received in groups of three, this works out well, provided that the trainees can be released from operational positions when ETG training is scheduled. If trainees are not grouped in threes, or if they cannot be released for training, then someone else in the facility must act as the pilot, or the ETG problem is derogated by having only one pilot or by having the EPDS act as both instructor and pilot. In the case of proficiency training (training received by FPL controllers) the problem of releasing three from a shift becomes more acute. Facility staffing sometimes permits diversion of personnel to support activities such as ETG. Many facilities, however, do not have sufficient staffing to support pilot positions on the regular full-time basis that the ETG training requirements are expected to demand. At times, therefore, the shortage of personnel to act as the pilots prevents the accomplishment of needed initial, subsequent, and proficiency training.

Yet another aspect of pilot position staffing, closely related to the question of who performs the pilot function, revolves around the ATC training value that is derived from performing as a pseudopilot. Opinions on this subject, pro and con, were found to be about evenly divided among training staffs at the facilities. The argument favoring the benefits states that beneficial training is derived in acquiring keyboard proficiency and also from observing the correct and incorrect control techniques and phraseology used by the trainee. The opposing view was that the keyboard entries made by the pseudopilot are unique to the pilot function and have no operational application, and that the pilot is so occupied with keeping up with the keyboard entries that he does not benefit from his exposure to the ATC aspects of the problem. There was general agreement that the training benefit gained in keyboard operation leveled off quickly after the first few months of experience. There was unanimous agreement that the total training benefit of acting as a pseudopilot is very small compared to the training benefit derived from performing the controller function in simulation (reference 8).

Several terminal facilities have reported that their FPL's are reluctant to perform the pseudopilot function.

Facilities that have hired target generator operators (TGO's) to perform the pseudopilot function (Miami and O'Hare) and predevelopmentals (St. Louis) are unanimously in favor of having hired TGO's based on their experience. The training time required for productive output has been minimal. Their performance of the pseudopilot task has been reported as excellent.

The economical aspects of source of persons to act as the pilots must also be considered. The limitations of a facility's controller staffing do not allow them to provide pilots for ETG training. Increasing the FPL controller complement just to provide such pilots is not justifiable nor economically sensible.

HARDWARE.

Displays. The use of one display with three keyboards for pilots, trainee, and instructor has two basic, inherent shortcomings. The first problem is that the pilots share the display with the controller. This is particularly distracting and unrealistic when a vertical display is used. The pilot position is a physically active one, with almost continuous keyboard entries being made. The pilots must view the display for every keyboard entry made (to see the preview area) and must also watch the targets they are responsible for. Four (or more) people crowded around one display, in what is often a very small space, simulating interphone and radio communications by talking "into thin air" is not a realistic environment. The same situation, with the addition of a communications system, would still be distracting to the controller and too unrealistic for the professional training that is needed. In short, the pilots should be remote from the controller.

The second problem is that three keyboards, ordinarily, are needed, one for each of two pilots and one for the controller. Unfortunately, the scenario entries must also use one of the keyboards as an input device. If a pilot, say, is in the process of composing a keyboard message, and a scenario event is called up, the scenario event will destroy the message being manually entered. This causes confusion, mistakes, and delays in pilot response to instructions.

Communications. The need for realistic communications in radar simulation training has been described in the section dealing with the extent to which ETG accommodates the training requirements. Of the 20 terminals surveyed, 11 have no communications in their ETG lab, 2 use the Bell 301A, 1 has a realistic simulated communications system, and the remainder have various versions of makeshift hotlines between the trainee and the pilots. Complaints about lack of communications were brought to our attention very early in the survey and were relayed to ATS prior to completion of the survey. ATS promptly convened a panel of training and other specialists who drafted requirements for a communications system that would meet the needs of ETG training.

Other Equipment. Considerably lower in priority, the need for simulated weather such as runway visual range (RVR), wind, and altimeter setting indicators was expressed by several facilities.

Computer Capacity. Several facilities reported that during peak traffic periods they are not able to utilize ETG, because of ARTS III track capacity limitations. This condition occurs chiefly when traffic delays are being experienced, which causes track tables to fill up. This shortcoming is expected to be cleared up at most, but not all, facilities with the scheduled delivery of additional memory modules. At least one facility (O'Hare) has this problem severely and regularly. O'Hare can no longer expand its track capacity, and they believe they need a separate Input/Output Processor (IOP) to support ETG.

Space. Terminal facilities have been forced to install their ETG displays in whatever space is available at the time. In a few facilities, this has produced an ETG lab about the size of a closet, creating a physically uncomfortable environment. Other facilities have installed the ETG display in a larger training room with somewhat better results, but usually at the cost of sacrificing some classroom space. It is felt to be significant, that O'Hare, with probably the best ETG lab of all the ARTS III facilities, is now seeking ways to remote the pilot positions from the controller positions. Facilities with prospects for new quarters may be able to design the ETG lab to fit their needs. An ad hoc committee convened by ATS in March 1978, recommended that a room 13 feet by 13 feet is the minimum size that should be considered for an ETG lab.

LOGISTICS. One problem is the length of time it takes for an EPDS to develop and document a training problem. Some staffs have reported that it takes one man 1 week to develop one "good" simulation problem. With experience, this can be reduced to 2 days, and a simple problem can be developed in 2 hours. But the major complaint is the length of time it takes to get a tape delivered after submitting the coded ETG problem. There are two initial stages to this process. First, the formatted problem is mailed to NAFEC. Cards are punched at NAFEC and mailed back to the facility. The cards are checked for accuracy at the facility, then sent to the assembly site for production of a magnetic tape. The tape is then mailed to the facility. This process can take up to 2 months. If a correction to the tape is desired, even a minor one, as it often is, the entire process must be repeated, or the tape must at least be returned to the assembly site for insertion of the correction(s). Again, a time-consuming process has to be gone through. Several facilities, through their own initiative, short-cut the process by punching their own cards at nearby FAA facilities that have the necessary equipment.

SOFTWARE. Several shortcomings exist in the ETG computer program. They have to do with realism of target response, unnecessary length of keyboard entries, and compatibility of keyboard entries in ETG with those in the operational program. Realism, particularly of target response and of keyboard entries made by the controller, is essential to simulation. A list of the suggested software improvements is contained in the section of this report entitled "Suggested Improvements." Positive and prompt action in eliminating these shortcomings is essential in order to permit ETG to meet the standards of professionalism that air traffic control demands.

DYNAMIC SIMULATION.

The DYSIM program, although presently quite realistic, has some staffing, software, and hardware shortcomings that prevent it from closely simulating operational conditions. DYSIM, as presently configured, is also lacking in the flexibility needed to utilize it to its best advantage as a training tool.

STAFFING. The number of persons necessary to support a simulation problem varies between facilities and within a facility on the type of training to be accomplished. The impact on personnel is not only on the training staff, but also on the FPL and developmental complement.

At the present time, simulation in most facilities is referred to as a "man eater." As many as eight support positions are being used for one training position. Although the ideal ratio might be one instructor to one student, a realistic ratio of two support positions to one training position is believed to be attainable by implementing software improvements.

Support. Most training staffs are enthusiastic and dedicated. They realize the value of training in general and particularly of simulation training available through DYSIM. The problem that exists is that there is a feeling of lack of support, in that training requirements are issued with apparent lack of regard as to how they are to get the job done. Staffing and equipment to accomplish the requirements at times have not been provided. Attempts to acquire the necessities are too frequently unsuccessful, usually because of lack of funds. Some staffs, still undaunted have, for example, paid for supplies with personal funds and have worked during off-duty hours, with no reimbursement, to set up a laboratory. Others are collecting bits and pieces of electronic components in the hope of assembling their own communications system. All facilities, however, are not staffed with such enterprising personnel, and they should not be expected to be. These facilities are also attempting, through normal procedures, to meet the requirements and to improve their training program and environment.

Training Staff. As stated under "Accommodating Requirements," present EPDS staffing at most facilities is insufficient to support the requirements levied on the facility. Another aspect of staffing, not as easily identified as the number of instructors required, is the instructor position itself. By this is meant the experience, knowledge, enthusiasm, and ability to instruct, as well as the incentives for attracting and retaining the best instructors possible.

The training program presently, at some facilities, is sustained by the innovative, enthusiastic staff of EPDS's that make the program work. Other facilities apparently have not been able to attract the best potential instructors to the position, since there is a loss in pay and benefits in moving from operations to staff.

The EPDS position is, and should be, a step in career progression, but this is the only apparent incentive for accepting the position. When compared to the loss in premium pay and other benefits, this incentive is not always enough to attract the best personnel to the position. Since the benefits are not very tangible, the better people, using the position for career progression, do not remain in the position very long.

Pseudopilots. The number of FPL's required to act as pseudopilots for the developmental training program varies with the size of the class. When not enough developmentals are in a class to perform the pilot duties for each other, FPL's are utilized. For the FPL proficiency program, only FPL's act as pilots. Although some training benefit might be gained in performing support duties, most facilities feel it is minimal and costly. Most felt that hiring a staff of pilot position operators is a more cost effective and efficient method of supporting simulation. The one enroute facility visited having pilot position operators (Los Angeles) was enthusiastic about their performance. It was found that the persons filling these positions were easy to train and enjoyed the job. The only regret for both the training staff and the pilot position operators is that since they were hired under the Comprehensive Employment Training Act (CETA) program, they could only be retained for 16 weeks. Although there was constant loss of experienced persons due to this, and a constant influx of new persons, a benefit was still realized. Other enroute facilities, not having pilot position operators foresee a problem in training pseudopilots and the competence of the persons filling these positions. However, the experience of the facility having operators does not support this viewpoint.

The pseudopilots' workload is such that, at most facilities, in the busier problems, the pseudopilot has difficulty in keeping up with the input of messages. This is usually rectified by adding more pilots to support the problem and dividing the workload. Many of the suggested software improvements relate to relieving the pilot of some of this workload (reference 4). The suggestions deal with providing the pilot the capability of inputting messages as soon as received instead of having to wait for target progress, eliminating the need for referring to conversion tables, reducing the number of calculations, and simplifying the necessary inputs.

HARDWARE.

Displays. Most ARTCC's have a sufficient number of displays, if used efficiently, to accommodate the training requirements. Modifications to the program that would increase the pilot capability and reduce the number of pilots necessary would be beneficial, whether controllers were acting as pilots or pilot position operators were hired for the function. This reduction in the number of pilot positions necessary to support a problem would result in the release of displays for the use of other students.

Only one facility reported an actual shortage of displays, and this was due to the usage of DYSIM displays to replace malfunctioning operational displays.

Communications. The most apparent hardware deficiency is in communications. A large portion of a controller's duties deals with communications, both in talking to pilots and in coordinating with other controllers and facilities. Although some laboratories are equipped with a communications system, it is rudimentary at best. A full communications system is not necessary, but a well thought out simulated communications system is definitely lacking. Inclusion of such a basic element of the system being simulated is essential to attain the degree of realism required.

A more realistic communications system would enhance the training effectiveness of simulation training. Communications and coordination are integral to the controller function and should be taught as realistically as possible in concert with radar training. Much of the controller's workload is done by rote so that the ability exists to cope with unusual situations or heavy workload. Much of communications can be classified as habit and the training of good habits for developmental controllers and those of full performance level can be accomplished during simulation training.

The question of how much realism is necessary is perhaps best answered by stating that it is directly related to the quality of training desired. To make an already qualified controller more proficient, and a developmental controller better trained, calls for quality training that simulates operational conditions as realistically as possible.

Other Equipment. Shortcomings in hardware are, for the most part, on a facility basis except for an improved communications system which is almost universal. Some facilities report the lack of an additional strip printer or PVD that would provide a more efficient utilization of DYSIM. Los Angeles, Oakland, and Miami ARTCC's requested that another flight strip printer be made available to the DYSIM laboratory. Kansas City ARTCC requested a method for communicating with the Data System Specialist in the operational area. Some facilities expressed the need for a card punch for the DYSIM laboratory. This need will be reduced as the use of scenario taped problems is introduced. Where scenario-tapes are in use, the need will exist for a 1052 typewriter, so that the necessary inputs may be made from the DYSIM laboratory.

Computer Capacity. Several facilities reported a computer response time slowdown that occurs most frequently during periods of heavy traffic and inclement weather. DYSIM is usually terminated during these periods at the request of operational personnel. There are no records to indicate the frequency of this occurrence, and the impact of DYSIM on the response time is uncertain, but DYSIM is being affected by this problem.

Space. The DYSIM laboratories visited were spacious enough to accommodate present requirements. Most of the space was being utilized and would become a factor only if additional equipments were required to perform the function.

SOFTWARE. The DYSIM computer program for the ARTCC's, although highly useful, is in need of increased realism and efficiency. Many items listed in the section entitled "Suggested Improvements" address these two subjects. Realism, in this case, refers to the simulated targets performing as closely as possible to that of an operational target, and efficiency refers to the software changes that would increase capability while reducing the number of pilots and keyboard operators required.

SUGGESTED IMPROVEMENTS

The improvements listed below were suggested by staffs at the terminal and enroute facilities surveyed. Some of them were discussed in previous sections of this report because they are associated with problems and shortcomings, but they also deserve mention as suggestions.

ENHANCED TARGET GENERATOR.

SOFTWARE IMPROVEMENTS. Numerous suggestions for software enhancements and problem solving were made. These suggestions will be documented separately in two NCP's (one containing high-priority changes and the other containing lower priority changes) and routed through normal configuration manangement channels. Some of these same suggestions were made previously through these same channels. They will be so identified in the documentation forwarded. At the risk of repetition, it is again noted that many of these software improvements are viewed as being positively essential to the effectiveness of the training program. The ETG improvements suggested are listed in appendix C, in order of estimated priority. The actual priority assignments will be determined as part of the NCP process.

OTHER SUGGESTED IMPROVEMENTS.

1. Pseudopilot positions should be remoted from the controller training position.

Comment: Some facilities, of course, already enjoy this condition, through the use of two displays. An experiment with a closed circuit television system for remoting pilot positions is being conducted at the Detroit TRACON. This experiment will be monitored with interest by Regional and Headquarters personnel. It can only be said that remoting pilot positions from a single display has yet to be accomplished. (The Conrac display, slaved from the tower bright TV display (BRITE), cannot be slaved from a DEDS.)

2. Isolate the training area from the operational area.

Comment: This suggestion was made by two facilities that are hampered by having to use an operational display for ETG. They are considering ways and means of segregating the display used for training without degrading its operational function. The problem should, of course, be resolved by establishment of an ETG lab, but as an interim measure, individual facilities facing this problem need a means of exchanging ideas on screening with portable sound-proof partitions, etc.

3. The capability to train two controllers simultaneously is needed.

Comment: This is being done at some facilities. Des Moines occasionally puts two trainees on a single vertical display, each supported by one pilot. One of the controllers is deprived of a keyboard in this operation. Its other limitations are obvious. Boston has used two displays for simultaneous training of radar controllers from non-ARTS sites. O'Hare, with four ARTS III displays available for training, also trains two controllers simultaneously.

If, at a particular facility, a horizontal display is used operationally (this is a necessary provision in the interest of realism), one is also available for ETG, and a separate display is available for pseudopilot positions, it is feasible to train two controllers simultaneously as long as they control traffic in separate geographical areas (i.e., they will see each others targets, therefore, they cannot both be trained on the same position of operation simultaneously). If four pilots are needed in this configuration, then one of them would have to sit at the horizontal display with the controllers. The only thoroughly acceptable way to train two controllers simultaneously (with the pilots remote from the controllers) is to use four displays; two for the four pilots and one each for the two controllers. It is not feasible, as far as we can determine, to put four pilots on one display, because four keyboards cannot be plugged into a single display, and remoting just the keyboard from one of the controllers' displays for use by a pilot would deprive the pilot of a preview area. The results of the Detroit experiment may be instructive here.

4. A voice recording capability would be beneficial for training for reviewing phraseology, microphone technique, and control instructions.

Comment: This feature has been included in the communications requirements documented by ATS.

5. A radar switch is needed at dual beacon sites so that either radar system may be selected for the ETG display(s).

Comment: Presently, displays at dual beacon sites are switchable from one radar system to the other, but not individually. Rather, only a predesignated series or group of displays can be switched. To permit switching of each individual ETG display would require that a switching or patching system be developed that would permit the selection of radar inputs to the display, consisting of trigger, normal video, Moving Target Indicator (MTI) video and map video plus synchro data. There is at present no such off-the-shelf system. In conjunction with switching the radar data, the software would need to be modified to permit the changing of the associated alphanumerics.

6. All the equipment (clock, RVR, wind, and altimeter setting indicators) that are used at the operational positions should be installed at the ETG position.

Comment: Such instrumentation is recommended as being conducive to realism.

7. Hired target generator operators (TGO's) are needed.

Comment: It is the judgment of the survey team that present staffing (developmentals and FPL's) should be relied upon as far as possible for the performance of this function. The justification for hiring personnel whose primary function is to act as TGO's exists only where the alternative is to increase the controller complement so as to accommodate this requirement. Other options also should be considered, such as designating this as a primary function (major job assignment) for predevelopmentals that are assigned to ARTS III facilities. The experience of facilities that use predevelopmentals should be examined from all aspects, including the benefit derived by the facility and the training benefit derived by the predevelopmental. Some experience with hired TGO's and with using predevelopmentals as TGO's has been gained. It has been reported that people who perform the pilot function regularly become and remain highly proficient at it, which may not be true of developmentals and FPL's who perform the function less often.

8. An increase in EPDS staffing was suggested strongly at almost all of the facilities surveyed.

Comment: This subject has been covered in the body of the report in conclusions and in recommendations.

9. An increase in controller complement to accommodate proficiency training was suggested.

Comments: Facility staffing is subject to many studies and formulae. Except as the problem might be resolved through the use of TGO's, it is outside the scope of the project and beyond the capabilities of the team members to evaluate this suggestion.

DYNAMIC SIMULATION

The suggested improvements that follow are those that were received from the enroute facilities visited and are not ordered as to preference. NCP case file numbers for the suggestions that are known to have been previously submitted are included in the text.

SOFTWARE CHANGES FOR IMPROVED PILOT CAPABILITY/ EFFICIENCY.

1. Capability for the pilot to specify the direction of turn while retaining the present capability.

Comment: Presently when a new heading is inputted the target turns to that heading in a direction that is the least change from its present heading. This is not always in the direction desired. The pilot must make this determination, and if an improper turn would result, must input headings that will result in a turn in the direction desired. This causes the pilot to make calculations and input two heading messages instead of one.

2. Allow the pilot to input indicated airspeed (IAS) and have the computer calculate groundspeed (GS).

Comment: The pilot receives speed commands in IAS and must refer to a chart to obtain GS based on altitude. Since the computer has the altitude of the aircraft, it would relieve the pilot if the IAS could be entered as received and have the computer do the conversion. This suggestion is in case file ZCDDS-CPF-132A.

3. Put IAS in Sim Data Block.

Comment: This would allow the pilot ready reference to the speed, if queried, instead of having to refer to a chart or strip.

4. Provide automatic speed reduction to 250 knots below 10,000 feet altitude.

Comments: This would relieve the pilot of inputting the speed changes which are not command but procedural changes. This capability is provided in case files ZSEAT-CPF-117B and AAT14-CPF-018.

5. Provide for the use of Mach speed in DYSIM.

Comment: This capability is provided in case file ZCDDS-CPF-132A.

6. Provide the ability to change speed while holding or when in a 360° turn.

Comment: At present, the pilot must make note of any speed change while in a turn, or hold, and input the change when the turn is completed. This suggestion would allow input when received.

7. Provide the ability from a pilot input to proceed direct to a navigation aid (NAVAID).

Comment: This relieves the pilot of calculating the appropriate heading for the target to proceed from present position to a NAVAID.

8. Provide multiple entry capability.

Comment: This would allow the pilot to input changes in speed, heading, altitude, and beacon without inputting the target identification for each separate function.

9. Provide the capability for the pilot to input a HOLD message, with direction of turn, at a future fix.

Comment: Presently, the pilot, upon receipt of a HOLD command, must make note of the command, monitor the target's progress until it reaches the specified fix, and remember to input the message at that time. This suggestion would allow the pilot to input the HOLD message as soon as received.

10. Provide for the target remaining in automatic mode when an altitude change is entered.

Comment: When an altitude change that changes the altitude to another altitude stratum is entered by the controller, the track goes from automatic to manual mode, which necessitates an additional pilot entry for every altitude change. Although this was apparently rectified by case file AAT-14-CPF-005, the problem still existed because of the wording of the case file. The case file stipulated that the problem existed when the change was entered by the target operator; however, the change from automatic to manual occurs when the controller inputs the altitude change requiring the operator to input a *"RESUME" message*.

11. Provide a fourth line in the pilots Full Date Block with sim track number and heading.

Comment: This appears to be an attempt to reduce the clutter of having two data blocks on the pilot display.

12. Provide for automatic sim target track start and automatic handoff from pilot to student.

Comment: This suggestion reduces the number of pilot inputs. Provision is made for this capability in "Sim Tape Input for DYSIM" (ZAUDS CPF-079A or ZMPAF-CPF- 053A).

13. Provide for the Simulation category in the pilots position to be preselected.

Comment: This would eliminate selection of the "Simulation" category for every message entry (ZAUSP-CPF-001).

14. Provide a means of eliminating the necessity of selecting some of the "simulation" functions by numerical coding.

Comment: This would eliminate the selecting of a function for specific entries by the use of two digits for heading, three digits for altitude, and four digits for speed.

SOFTWARE CHANGES FOR INCREASED REALISM IN TARGET PERFORMANCE.

1. Change unrealistic tight turn and unrealistic speed reduction on a 360° turn when entered without an asterisk (*).

Comment: For example, a high-performance target presently makes a very tight turn of approximately 3 nmi, and the speed reduces from 450 knots in increments of approximately 50 knots per scan. After the turn is completed, the speed increase rate to assigned speed is at the normal acceleration rate. Since the reduction was so drastic, it now takes some time before the target reaches that speed.

2. Eliminate target jump when going from manual to automatic.

Comment: The target, when nearing the adapted flightpath, jumps about 4 nmi to the center of the airway. This is distracting and causes a loss of separation at times.

3. Provide the ability to vary the climb/ descent rate.

Comment: This provision is contained in case file ZOBDS-CPF-057.

4. Provide a more realistic turn rate and the ability to vary the rate manually.

Comment: When entering a heading change, it appears that the target immediately turns about 15° and then continues the turn at 3° per second. The initial sudden change is unrealistic.

5. Provide for manually input variable-speed change rates.

Comment: This would provide the flexibility of selecting different speed change rates for targets of like performance.

SOFTWARE CHANGES FOR A MORE REALISTIC ENVIRONMENT OR MAKING DYSIM A BETTER TRAINING TOOL.

1. Replace XXX with a one-letter code such as a question mark.

Comment: This would provide for a larger, more realistic selection of identifications for targets, give a more realistic and less distracting display (ZCDDS-CPF-138).

2. Provide more flexibility in the use of conflict alert for training that would allow for "inhibit," "select all," and "select" for specified targets.

Comment: This would provide for training that is progressive in the use of conflict alert. In training it is not always desirable to be forced in the use of this enhancement.

3. Provide the ability to freeze a problem without impacting other ongoing problems.

Comment: This would allow the instructor to stop an individual problem for discussion or teaching without interfering with other problems in progress.

4. Restrict operational winds and provide the ability to input simulated winds and weather.

Comment: This would allow the instructor to train with the use of selected winds and weather and yet allow for standardized winds and weather for pass/ fail testing.

5. Provide the capability to handoff traffic to other sectors using realistic sector numbers.

Comment: Provision for this suggestion is contained in case file AAT-14-CPF-016.

6. Enhance primary targets from a dot (.) to a plus (+).

Comment: Provision for this suggestion is made in AAT-14-CPF-016 and is contained in system tape A3D2.5.

7. Provide ability to drop all targets for independent sectors with one message.

Comment: This would allow for the termination of a simulation with the input of one message to drop all tracks.

8. Provide for DYSIM recovery after a system flop.

Comment: This would provide for the continuation of training after a system abort without the need for a complete restart. This is provided in system tape A3D2.6.

9. Provide the capability to stop training (ST OFF) by problem.

Comment: This would provide the ability to stop one problem without impacting a second ongoing problem.

10. Provide DYSIM combined sector independence.

Comment: This would allow the DYSIM lab to combine or decombine sectors irrespective of the operational configuration.

HARDWARE IMPROVEMENTS.

1. Provide a more realistic communications system.

2. Provide an additional card reader for the DYSIM lab.

3. Provide a 1052 typewriter in the DYSIM lab, DYSIM eligible only, for scenario input.

4. Provide a card punch to training.

5. Provide additional strip printer in lab.

IMPROVEMENTS NOT PREVIOUSLY CLASSIFIED.

1. Provide additional staffing to training to increase DYSIM usage.

2. Provide objective training tools to the instructor for use in counseling and teaching; i.e., printout of separation errors, playback of problem, etc.

3. Provide ability to make "Simulation" entries from the pilot "D" position.

4. Extend DYSIM training and reduce the maximum OJT hours.

5. Provide pilot consoles to release PVD's for training.

6. Provide a steady influx of students in optimum numbers for a class.

7. Improve the five-patch limitation so that an extra one is set aside for DYSIM and provide that it can contain more than one modification.

8. Hold a series of workshops for the EPDS's in charge of DYSIM training to unify effort.

9. Provide the capability for the pilot to change the leader length for individual data blocks.

10. Provide a method of dividing a formation flight that will result in a realistic operation.

11. Provide a parameter for tracks that are locked in coast to be dropped automatically.

12. Provide DYSIM with an independent computer interfaced with the operational computer.

CONCLUSIONS

GENERAL.

1. DYSIM and ETG are powerful and effective training tools, capable of promoting safety, economy, and professionalism in air traffic control.

2. The five-patch limitation imposed by National Order 6120.1 (reference 11) is limiting the enhancement of simulation capability needed to enhance training at some facilities.

3. A reporting system statistically delineating the utilization of DYSIM and ETG, the results achieved, the problems encountered, and the resources necessary to provide necessary support is lacking.

4. There is a lack of communication between field training staffs on a national basis for problem solving and the development and evaluation of new ideas and techniques.

5. The quality of radar training in the field is adversely affected by the lack of a laboratory communication system which realistically simulates the operational environment.

6. The controller complement at some facilities is not sufficient to provide pseudopilots for all the training required. A new source of pseudopilots, other than FPL controllers, is needed at these facilities.

7. The training benefit derived from acting as a pseudopilot is inversely proportional to the air traffic control experience level of the person performing that function.

ENHANCED TARGET GENERATOR.

1. The extent to which ETG accommodates the training requirements varies widely from facility to facility, completely failing at some facilities, succeeding rather well at others, and lying somewhere in between these two extremes at the rest.

2. ETG is underutilized at many facilities, primarily because of an insufficient number of EPDS's available to support it.

3. ETG training should be administered by a qualified instructor to assure professional results.

4. Close cooperation between training staffs and data systems staffs, and assumption of responsibility for the technical aspects of the ETG training program by the data systems staffs, are essential to a successful and smooth-running ETG training program.

5. The quality of ETG training is adversely affected by the use of a single display shared by pilots and controllers. It is further concluded, therefore, that in the absence of a special purpose pilot console, two ARTS III displays is the minimum number that is needed

to conduct successful, professional simulation training.

6. When the training load at a facility can only be satisfied by training more than one controller at a time, additional ARTS III displays (more than two) will be needed in that facility's ETG lab.

7. The elements necessary for a successful ETG program seem to be, in order of importance, a motivated and adequate EPDS staff, a supportive data systems staff, and adequate equipment.

8. The logistics problems involved in developing and correcting scenario tapes causes delays in implementing ETG training and in making ETG training problems replicate current facility practice.

9. ETG software enhancements are urgently needed to increase the realism of target responses, to simplify and reduce the number of pilot keyboard entries, to make controller keyboard entries in ETG identical with operational keyboard entries, and to simplify the production of scenario tapes.

10. Supportive documentation of ETG problem development and problem administration is needed by facility training staffs. The most current documentation has become obsolete.

11. The ultimate aims of ETG training will not be accomplished until realistic interaction between radar controllers is introduced in simulation.

DYNAMIC SIMULATION.

1. Modifications to the DYSIM program are needed to more fully realize its potential and to reduce the large support requirements.

2. Simulation training is costly in its support requirements since GS-11 to GS-14 grade persons are utilized as pseudopilots for the person in training.

3. The EPDS complement is insufficient to support the prescribed training requirements.

4. The influx of developmental controllers is sporadic and at times the number in a class is too large or at other times the number is too small to efficiently provide DYSIM training.

5. System/computer response time slowdowns adversely affect DYSIM.

RECOMMENDATIONS

It is recommended that further enhancements to the simulation training program be made in the following areas:

GENERAL.

1. Provide an additional patch to the five-patch limitation for the exclusive use of local simulation system modifications.

2. Institute a reporting system that would provide current information on DYSIM utilization and, more importantly, the extent to which it is adversely impacted by operational priorities.

3. Provide a source of personnel, either hired TGO's or predevelopmentals, to perform the pseudopilot function at those facilities and at those times that the controller complement is insufficient to support this task.

4. Provide a medium for the dissemination of information on simulation training. This could be in the form of workshops, seminars, newsletters, or a combination thereof, that would reach, and allow participation by, training and data systems staffs from every facility.

ENHANCED TARGET GENERATOR.

It is recommended that the following steps be taken to enhance the quality of ETG training and to effect its full utilization at all ARTS III facilities.

1. Increase the EPDS staff to the extent that an EPDS will be available to administer all scheduled ETG training during the administrative work week. In those facilities that require the administration of more than approximately 1,800 hours of ETG training per year, increase the EPDS staff to the extent necessary to provide an EPDS on the second shift as well.

2. Recognition should be given to the fact that developing ETG scenarios and using the ETG program to its fullest advantage requires the full support of the data systems specialists in a cooperative work program with the training staff.

3. Provide two ARTS III displays as a minimum for each ETG laboratory. Where the training load demands that two or more controllers be trained at a time, provide additional pairs of ARTS III displays.

4. Implement the first 15 software changes of appendix C as a high-priority consideration. The additional changes identified in appendix C should undergo field evaluation for development of appropriate software changes to relieve the problems identified and evaluate impact. NCP's have been prepared to facilitate processing.

5. Revise the Radar Problem Development and Administration Guide, TI-V-O, to reflect current ETG capabilities, including the development and use of scenario problems.

6. Require facilities to utilize ETG training to the fullest extent, consistent with the resources provided to do this and consistent with the benefits that ETG can provide.

7. Provide an additional IOP, or some other means of relief, for facilities such as O'Hare whose training is regularly interrupted by operational demands on the ARTS III.

8. Provide a realistic communications system in each ETG laboratory, as described in Communications Requirements developed in the ATS-sponsored workshop in December 1977.

DYNAMIC SIMULATION.

1. Increase the EPDS complement to provide for the utilization of DYSIM on a 16-hour day/7-day per week basis.

2. Provide for the steady influx of developmental controllers in numbers that are in agreement with the requirements and the facility's ability to provide optimum training.

3. Ascertain the cause of and correct the slowdown in computer response time.

4. Implement the software changes in appendix D as a high-priority consideration. NCP's have been prepared to facilitate processing. The additional changes identified under Suggested Improvements should be considered for implementation pending additional evaluation of their value and impact.

5. Upgrade the laboratory communications system to more realistically simulate the operational environment.

REFERENCES

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2. Terminal Instructional Program Guide, TP-12-0-1, May 1976.

3. En Route Instructional Program Guide, EP-12-0-1, October 1976.

4. Air Traffic Training, Handbook 3120.4D, December 1975.

5. House, K., Karovic, S., and Rundall, T., Simulator Pilot Consoles for NAS En Route and ARTS III Facilities, DOT, FAA, National Aviation Facilities Experimental Center (NAFEC), Atlantic City, N.J. 08405, Report No. FAA-RD-77-136, November 1977.

6. ARTS III Computer Program Functional Specifications (CPFS), NAS MD 608.

7. National Airspace Systems Configuration Management Document Model A3d2 En Route Stage A Computer Program Functional Specifications Dynamic Simulation of Radar Data, NAS MD 323, November 15, 1975.

8. En Route Radar Problem Development and Administration Guide, EM 12-0-2, January 1976.

9. Terminal Radar Problem Development and Administration Guide, TI-V-O, January 1975.

10. National Airspace System Configuration Management, Order 1800.8D, March 26, 1975.

11. Field Participation in Discrete Operational Program Modification, Order 6120.1, August 19, 1974.

FIGURE 1. DYSIM LAB WITH EIGHT DISPLAYS--NEW YORK ARTCC

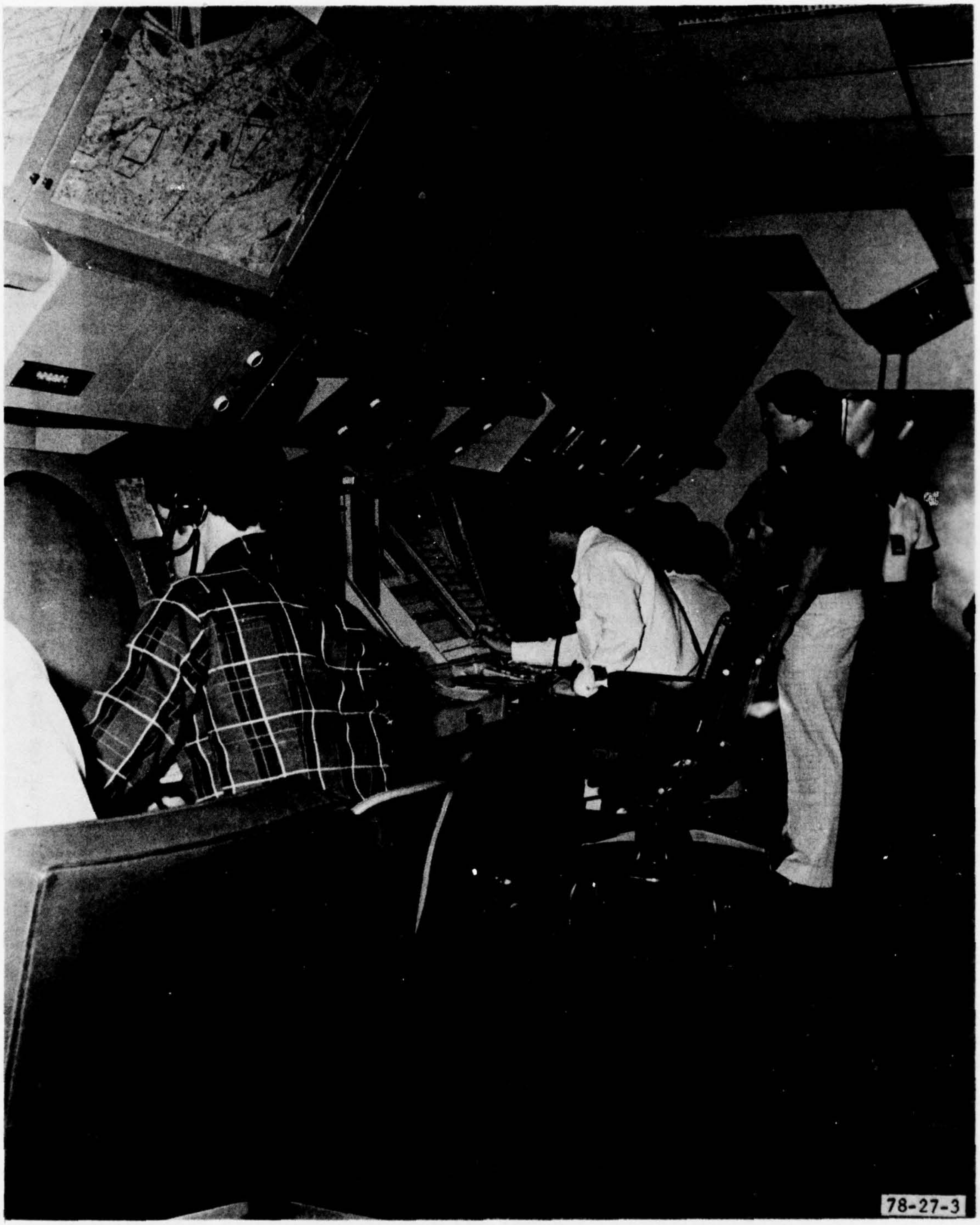

FIGURE 2. DYSIM LAB WITH FOUR DISPLAYS INLINE--BOSTON ARTCC

FIGURE 3. DYSIM LAB WITH FOUR DISPLAYS INLINE--OAKLAND ARTCC

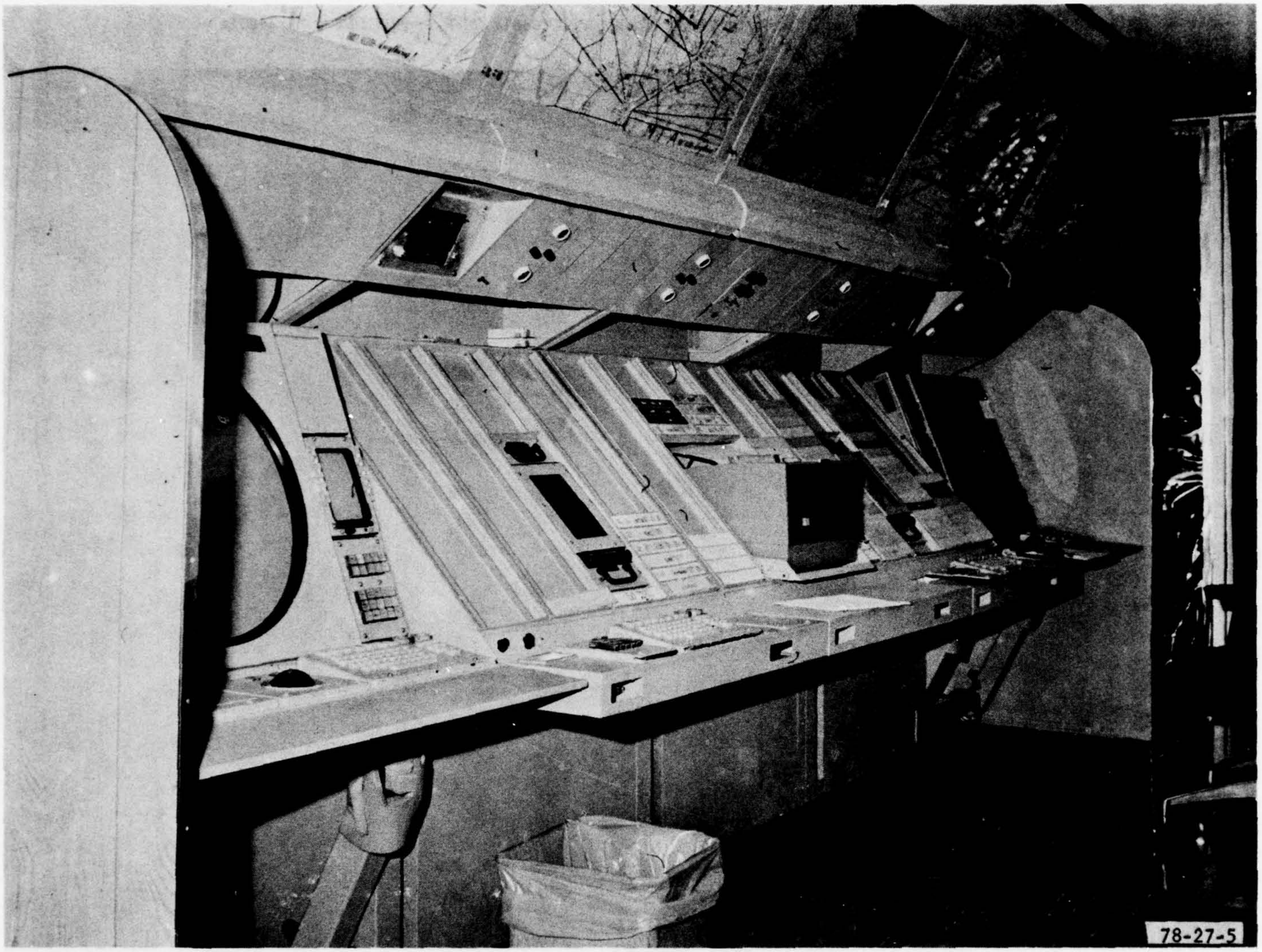

FIGURE 4. DYSIM LAB WITH TWO DISPLAYS BACK-TO-BACK--HOUSTON ARTCC

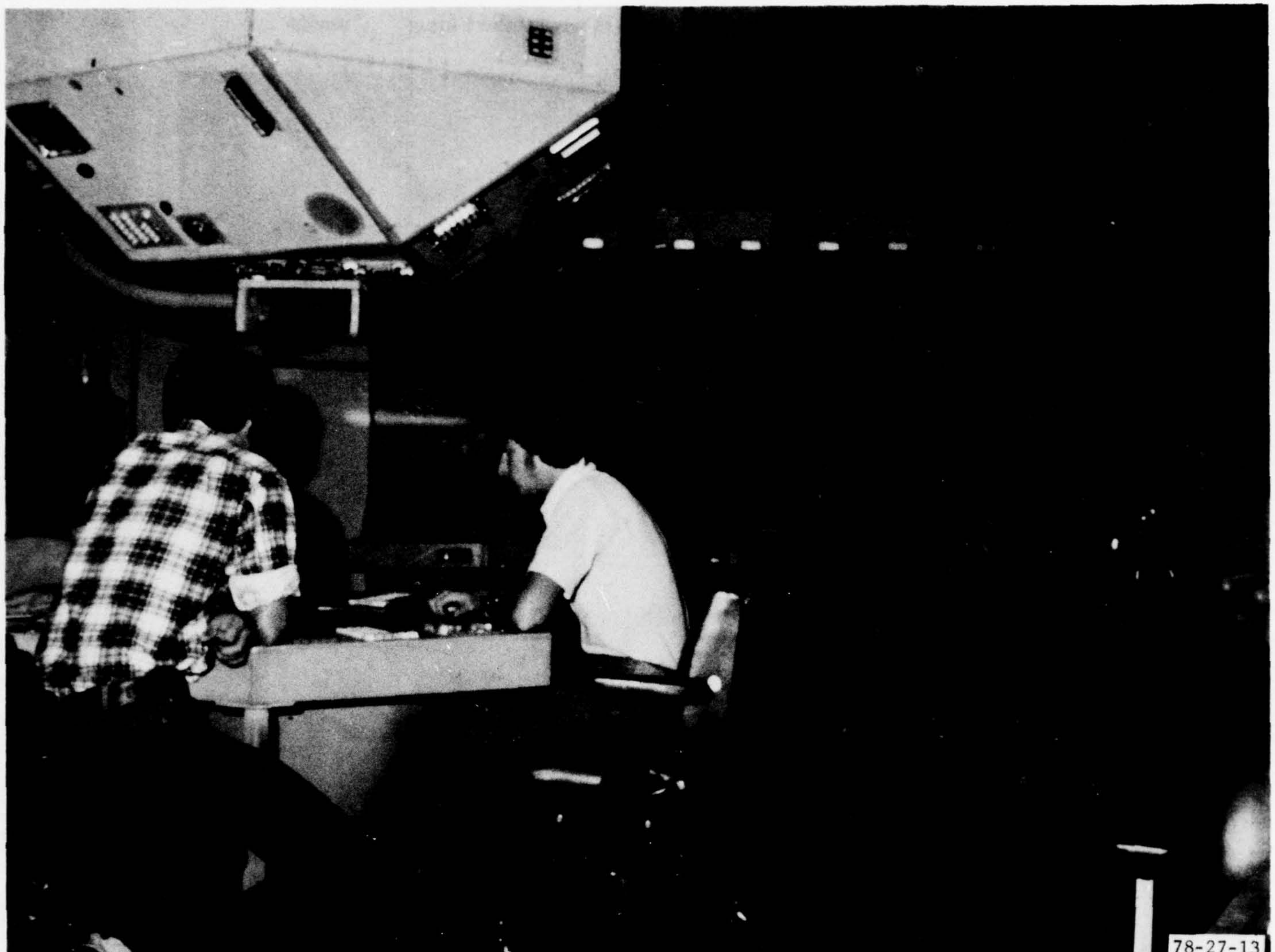

FIGURE 5. ETG LAB--O'HARE AIRPORT (A FOURTH HORIZONTAL DISPLAY IS NOT SHOWN)

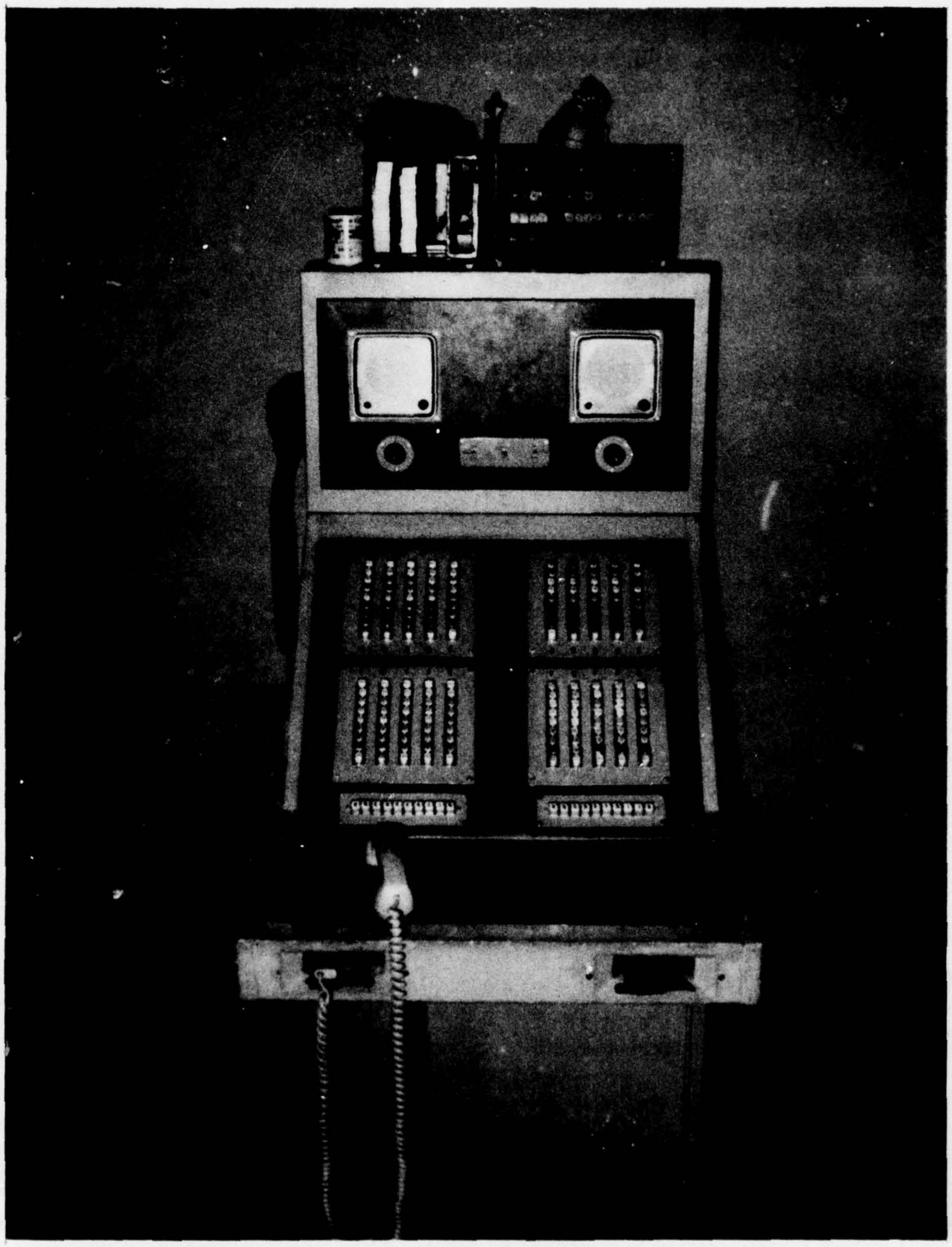

FIGURE 6. SUPERVISORY CONTROLS FOR ETG COMMUNICATIONS AND RVR--O'HARE AIRPORT

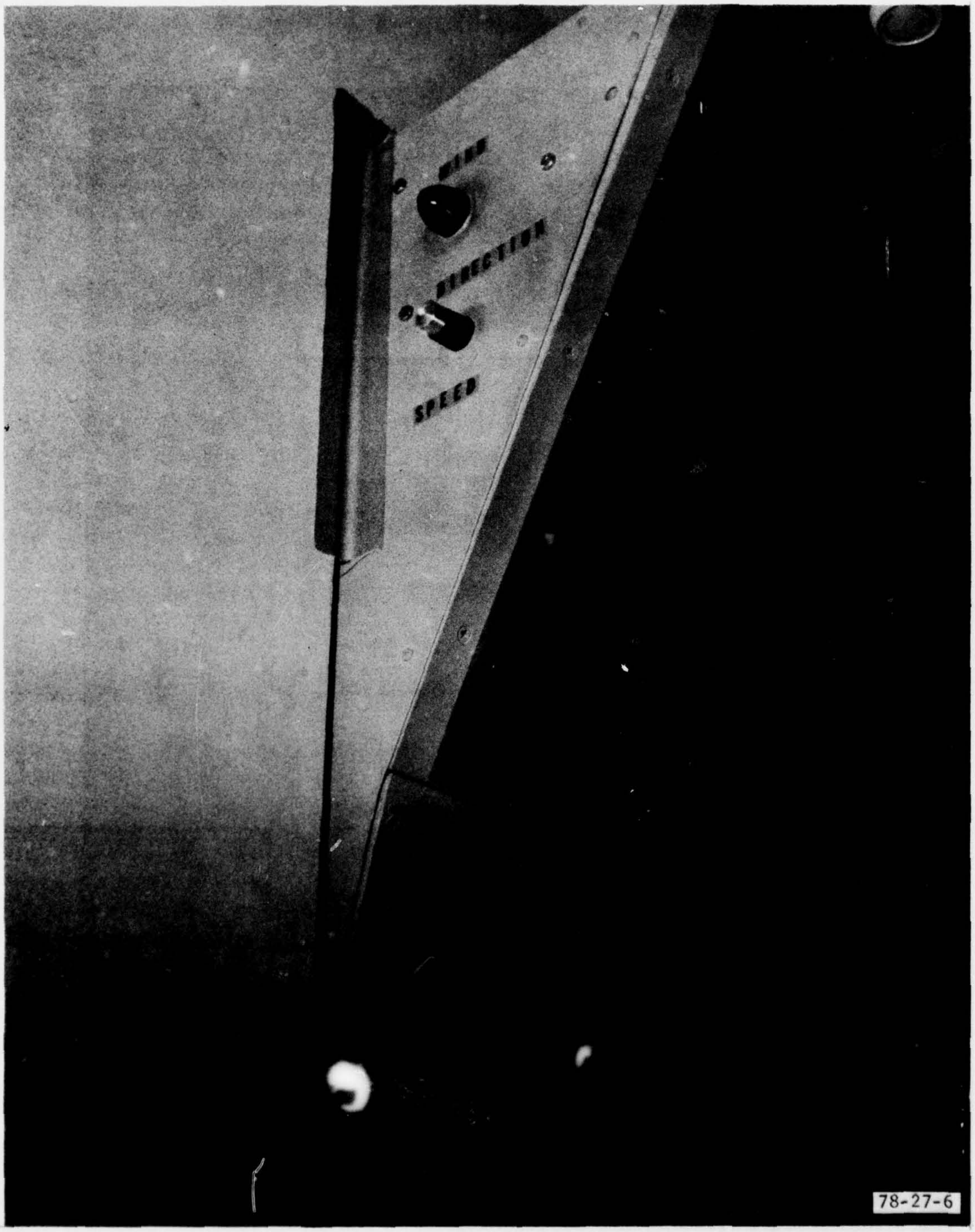

FIGURE 7. ETG LAB CONTROLS FOR WIND DIRECTION AND SPEED INDICATORS--O'HARE AIRPORT

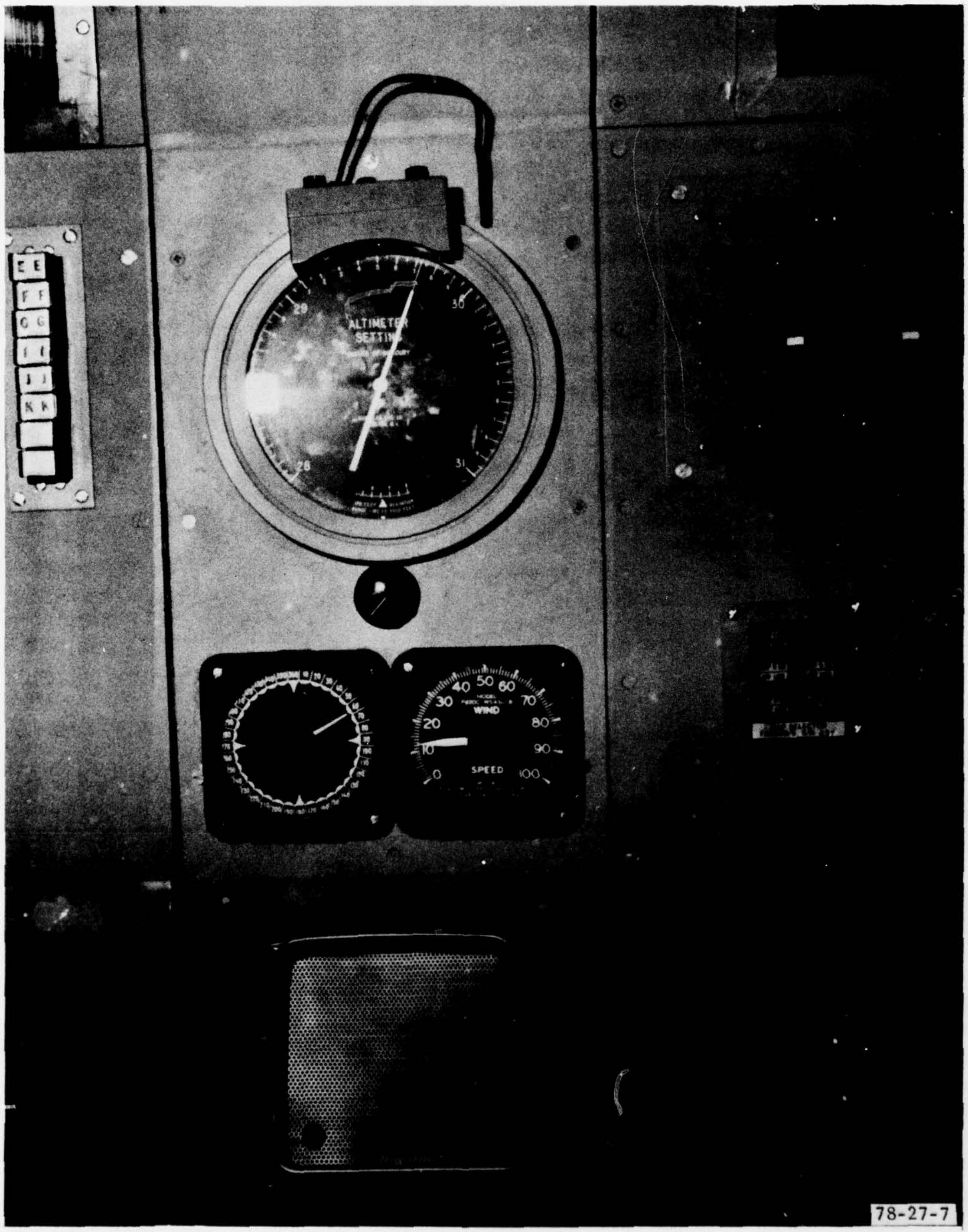

FIGURE 8. ETG LAB SIMULATED WIND AND RVR INPUT--O'HARE AIRPORT

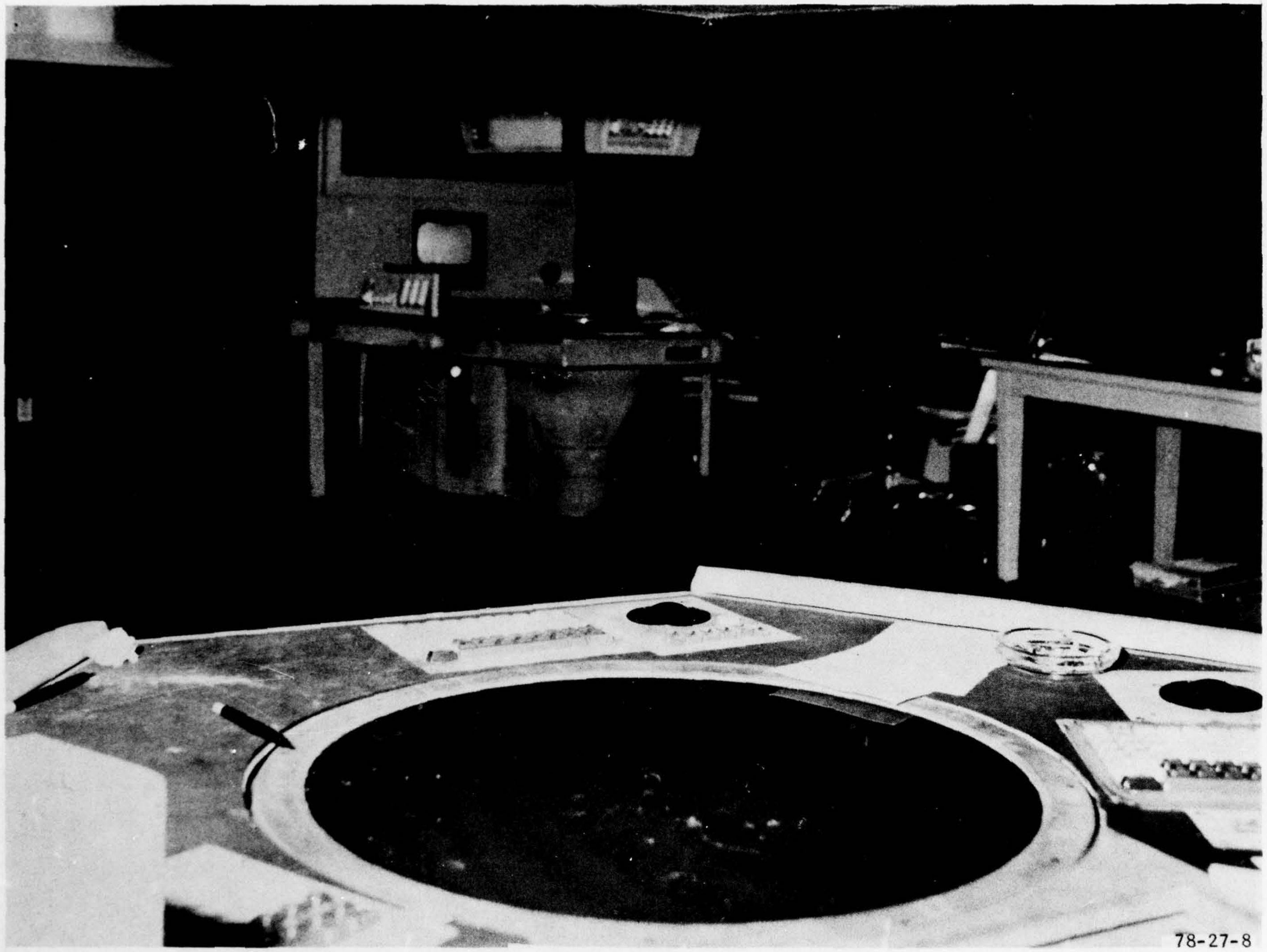

FIGURE 9. ETG LAB--OAKLAND AIRPORT

FIGURE 10. ETG LAB WITH STUDENT AND INSTRUCTOR--DETROIT AIRPORT

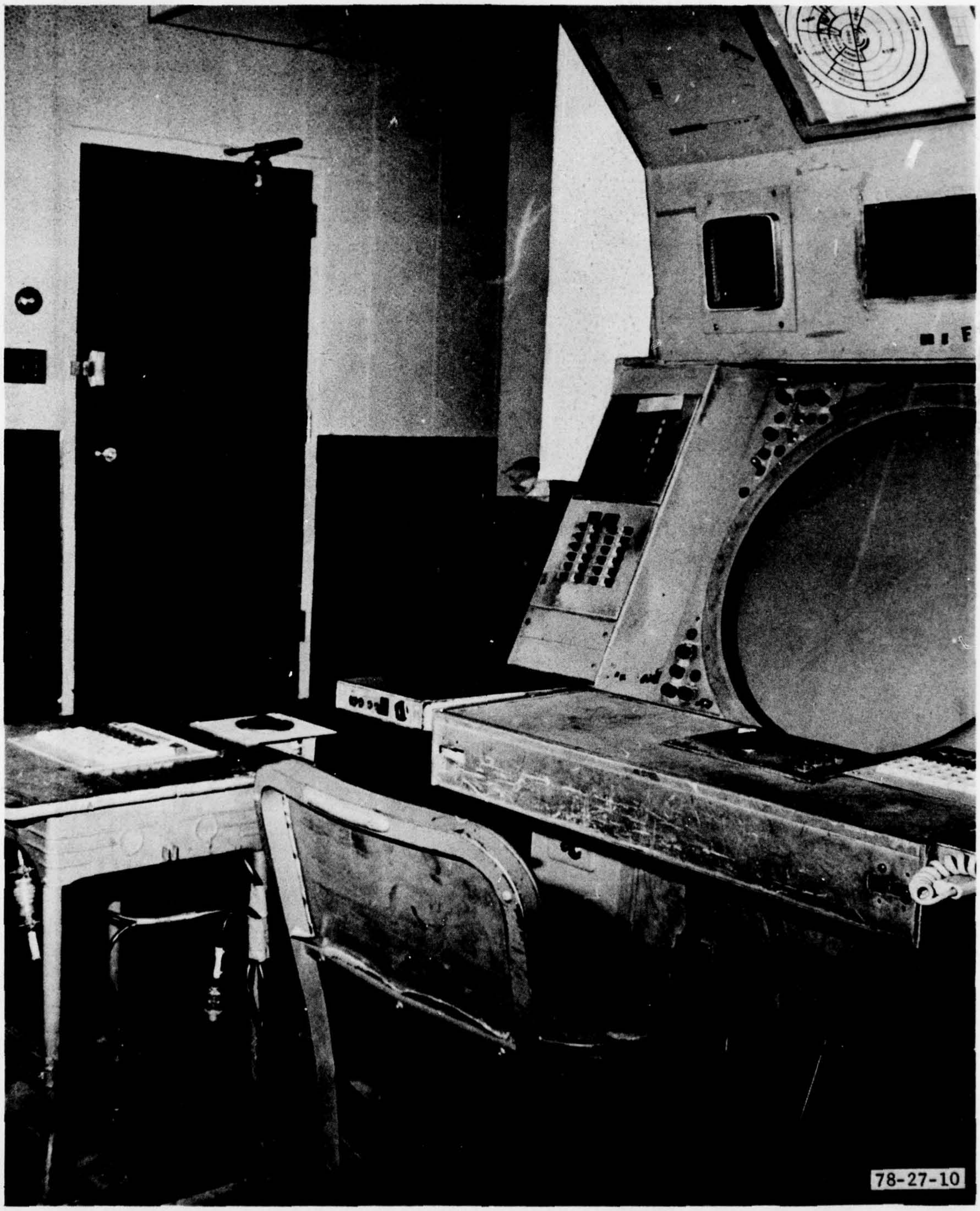

FIGURE 11. ETG DISPLAY WITH PILOT KEYBOARD MOUNTED IN TYPEWRITER STAND--BOSTON AIRPORT

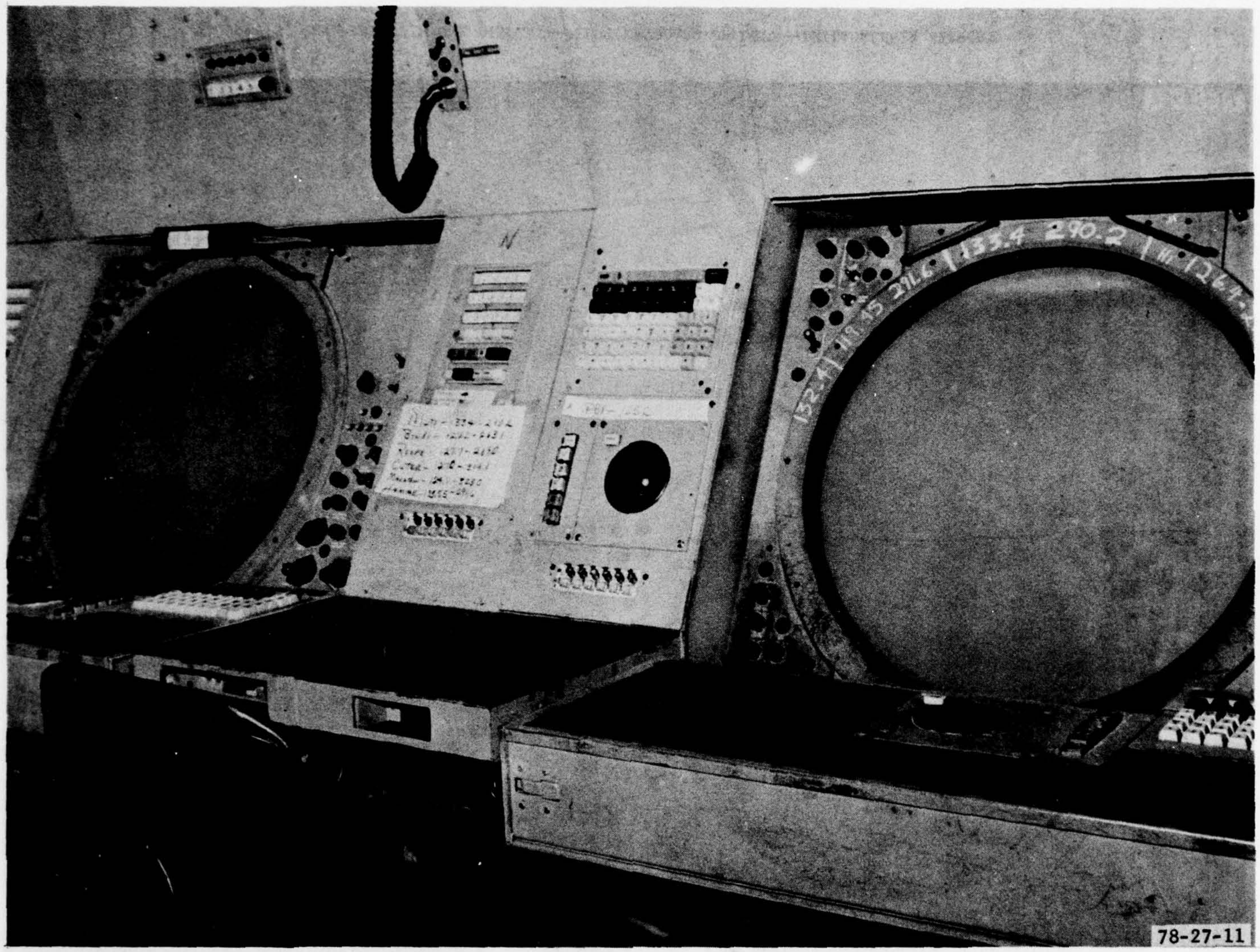

FIGURE 12. ETG LAB WITH TWO DISPALYS--MIAMI AIRPORT

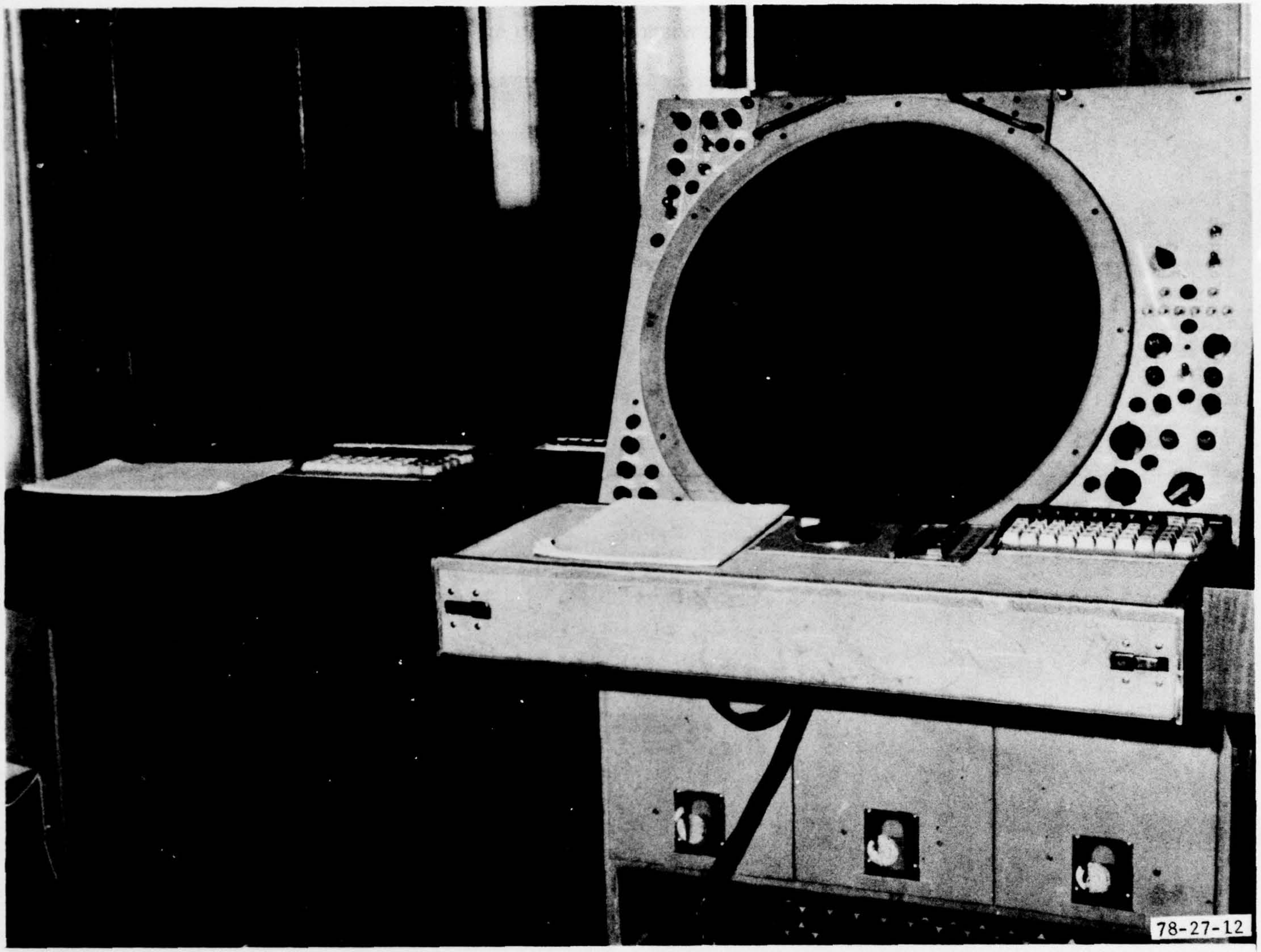

FIGURE 13. ETG LAB WITH ONE DISPLAY--PILOT KEYBOARD ON LEFT--PHILADELPHIA AIRPORT

APPENDIX A

QUESTIONNAIRE/CHECKLIST USED IN SURVEY

_____ Amount ETG/DYSM utilized

_____ Time of utilization (shifts, weekends)

_____ Types of training performed

_____ Other purposes for which simulation is used

_____ Facility controller complement

_____ Number of FPL's, developmentals, experience level of developmentals

_____ Training staff

_____ Amount of time devoted to radar simulation by training staff

_____ Support required for simulation (pilots, controllers, instructors, others)

_____ DSS support

_____ Use of scenario tapes

_____ Adherence to Radar Problem Development and Administration Guide

_____ Insertion of unusual situations into problems

_____ VFR traffic and Visual Approaches

_____ Training in interaction between adjacent radar positions

_____ Number of flights in a 100-percent problem

_____ Duration of problems

_____ Number of problems that can be administered in a day

_____ Number of controllers that can be and are trained simultaneously

_____ Mixing simulation training with OJT

_____ How long simulation training has been in use

_____ Number of students, by category, that have been trained

_____ Pass/Fail testing and washout rate

_____ Length of time required to complete simulation training and to become certified

_____ Training requirements vs. resources

_____ Seasonal fluctuations in training

_____ Equipment used for simulation training and its adequacy

_____ Voice recording of training sessions

_____ Coordination in simulation

_____ Simulation of broadband video

_____ Computer capacity vs. training function

_____ Results of simulation training (such as, but not limited to, reduced OJT)

_____ Objective and subjective measures of results

_____ Negative results

_____ Shortcomings in simulation training

_____ Suggested improvements

APPENDIX B

FIELD FACILITIES SURVEYED

EN ROUTE		TERMINAL	
Washington	6/01/77	Dulles	6/07/77
Boston	6/27/77	Boston	6/27/77
Seattle	7/12/77	Quonset Point	6/28/77
Kansas City	8/09/77	Windsor Locks	6/28/77
Chicago	8/10/77	Seattle	7/12/77
Los Angeles	8/23/77	Portland	7/12/77
Denver	8/25/77	St. Louis	8/09/77
Miami	9/13/77	Chicago	8/10/77
Houston	9/15/77	Los Angeles	8/23/77
Oakland	9/27/77	Denver	8/25/77
		Miami	9/13/77
		Houston	9/15/77
		Oakland	9/27/77
		Philadelphia	1/09/78
		Louisville	1/09/78
		Jacksonville	1/10/78
		Dallas	1/10/78
		Detroit	1/11/78
		San Antonio	1/11/78
		Des Moines	1/12/78

APPENDIX C

SUGGESTED SOFTWARE IMPROVEMENTS TO ETG

Prepared By
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The following changes have been selected from those requested, as the most beneficial for improving training effectiveness. Evaluation of the potential cost of the change in terms of computer capacity, programing, etc. was limited; however, the impact of the Recommended Improvements (first 15 suggested changes) are not considered to be of such magnitude as to outweigh their benefits. These modifications are a must if the ETG program is going to meet the needs of proficiency training. The remainder are additional suggestions considered as beneficial to improved training and are recommended for inclusion pending an evaluation of their feasibility (e.g., whether the benefit received justifies the cost in core, processing, and programing). NCP documentation has been prepared for the suggested changes to facilitate processing and implementation.

RECOMMENDED IMPROVEMENTS.

1. PROBLEM: The final approach intercept routine is in need of modification. As presently designed, it has the following shortcomings:

a. When the automatic approach keyboard entry is made, the target proceeds direct to the final approach gate, instead of continuing on the last assigned heading until intercepting the final approach course. This is unrealistic as it "bails out" the trainee who has assigned a bad heading and, in reality, an aircraft flies the last assigned heading until intercepting the final course.

b. All targets reduce (or increase) speed to 120 knots on final approach. This speed is not representative of the preponderance of traffic handled at many, if not most, ARTS III facilities. Of even greater significance, this common speed conditions the trainee to disregard aircraft performance characteristics which affect separation during the final approach portion of the approach.

c. The "aircraft" cannot be cleared for approach with an instruction to maintain an altitude until passing X (fix). Rather, upon being cleared for approach, the target immediately and automatically descends to the final approach fix altitude. Thus, actual approach control procedues used at many facilities cannot be duplicated in ETG.

d. If the target is turned onto the final approach inside the approach gate, the target automatically makes a turn back to the approach gate, creating an unrealistic and disruptive situation.

e. The missed approach speed is unrealistically slow for traffic at most facilities.

f. The keyboard entry for automatic approach is unnecessarily lengthy, requiring 10 keys to be depressed. This number could be reduced to five.

RECOMMENDED CHANGES:

a. Continue aircraft on the last assigned heading until intercepting the final approach course.

b. Make the speed reduction for the approach site adaptable (see problem 2).

c. Modify keyboard entry for automatic approach as follows:

(1) The ident of the primary airport will be implied. (A typical entry for LAX would be F15, N, 09 enter. When implied ident is used, the runway must be specified by two or three alphanumeric characters.)

(2) Allow the entry of three primary approaches at the start of a problem and thereafter referenced by 1, 2, or 3. (The keyboard entry to clear an aircraft for the first entered approach would be F15, N, 1 enter and similar entries for the second and third approach.)

d. Establish another altitude and approach fix (fix three) on the final for each adapted approach to be used as follows:

(1) If fix three altitude is set to zero, aircraft would start its descent to altitude specified in fix two, when the aircraft is cleared for the approach.

(2) If fix three distance is set to zero, the aircraft, when cleared for the approach, would descend to the altitude specified in the fix and upon intercepting the final approach course would descend to the altitude specified in fix two.

(3) When neither the altitude nor approach fix is equated to zero, the aircraft will maintain last assigned altitude until intercepting the final approach, at which time it will descend to the altitude specified in the fix. When passing the newly adapted approach fix, the aircraft will descend to the altitude specified in fix two.

e. Modify program to allow approach intercept at any point on the final. (When the turn-on is inside any of the adapted fixes for the approach, the aircraft will be allowed to make the approach without making a 360° turn.)

f. When an aircraft is cleared for an automatic approach, its speed will not be changed if it is less than the adapted approach speed.

g. Descent rate from approach fix to touchdown should be site adaptable (see problem No. 2).

h. Establish an ETG data word for antenna scan time. (The parameter would be site adaptable to allow each facility to establish the glide slope angle needed for their airport.)

i. Reference case file Number ORDDS - CPT-081, Item 4-C. Adjust rate of descent on final, from approach gate to touchdown, to reference aircraft speed. (This would be used in conjunction with item h above to establish needed glide slope.)

NOTES: When an aircraft is cleared for an approach:
In change d-1 (above), the program would continue to operate as it is now.

In change d-2, when the distance for fix three is set to zero, the aircraft will descend to the altitude specified in fix three and when intercepting the approach course it will descend to the altitude specified in fix two.

In change d-3, the aircraft would maintain last assigned altitude until intercepting the apporach course. It would then descend to altitude specified in fix three. When the aircraft passes fix three, it will descend to fix two altitude. When it passes fix two, it will descend to fix one altitude, etc. When an aircraft intercepts the final approach course inside of an adapted fix, it will descend to the altitude of the next fix; e.g., if it intercepts inside of the outer marker (fix one) it will start its descent to touchdown altitude.

2. PROBLEM: ETG enhancements are urgently needed to simplify and reduce the number of pilot keyboard entries and to increase the realism of target responses. The workload of the pilot position is a definite factor on the outcome of a simulation problem. The student will often instruct an aircraft to proceed "direct" to a navigational aid or follow an aircraft in a landing sequence. The pilot must convert these instructions to a heading. This is very time consuming.

The only method of simulating a route of flight is by heading and time. There is no practicable method of simulating STAR, SID, high profile routes, or to program a flight for a jet penetration. When time and heading is used to program a route of flight, any change in wind, speed, time, or altitude will affect the flight and cause the aircraft to be off course. What is needed is a method of programing a route of flight that will not be affected by changes other than a heading.

Another change to reduce pilot entries and to add realism to the ETG program is a series of tables that would contain eight categories of aircraft operating characteristics. The aircraft category would be entered when the target is entered, it may be modified at any time, and if not selected, category 3 will be assumed.

RECOMMENDED CHANGE:

a. Modify ETG program to accept a keyboard entry to automatically assign a heading for an aircraft to fly from its present position to point "A," then point "B," then to point "C." A subroutine, as used in the automatic approach routine, would be used to correct the heading to assure the target would proceed to the selected kepoints. Keyboard entry should be minimal; e.g., F15, TN, D, D1, or D2.

Any subsequent use of the "D" function, or any change in heading, would cancel the previously selected route of flight.

b. Establish a series of site adaptable tables that will contain operating characteristics of eight categories of aircaft.

The tables will contain data for:

(1) Climb rate

(2) Descent rate

(3) Velocity change rate

(4) Turn rate

(5) Initial approach speed (speed of aircraft from the time cleared, to the approach gate)

(6) Interim approach speed (approach gate to approach fix)

(7) Final approach speed (approach fix to touchdown)

(8) Missed approach speed

(9) Cruise speed below 10,000 feet

(10) Cruise speed 10,000 feet and above

The category of aircraft may be entered when the target is initiated, it may be modified, and if not entered, category 3 will be assumed. Keyboard entry should be minimal; e.g., F15, TN/0-7. The instantaneous feature for speed, heading, and altitude will remain in the program. When an aircraft leaves 9,900 feet on a climb or vacates 10,000 feet on descent, the appropriate site adaptable speed will be automatically selected (tables 9 and 10).

3. PROBLEM: Some facilities have scenario problems built for entry at a position other than the ETG display. When this display is not available, the only method of using the tape is by making a memory change to modify the TSDIQ table (a table that identifies the display and keyboard used for ETG scenerios). A keyboard entry is needed that would allow scenario input to be changed from one display to another.

In the live environment, a position may be combined so that data assigned to that position will be rerouted to the appropriate position. In ETG, if you reference a keyboard not in ETG status, the message is rejected. The program should be modified so that when a referenced keyboard is not in ETG status it will check a table to determine if the data should be rerouted or rejected. This change will also add realism to the radar simulation problem. These changes will provide the means of training from different displays while utilizing the same scenario problem.

RECOMMEND CHANGES:

a. Modify program to allow scenario input to be changed from one display to another. This change should be a keyboard entry so as to allow EPDS and supervisory accessibility.

b. Institute ETG keyboard configuration table so as to allow combining of ETG-referenced positions. This change could be used in conjunction with the above change or it would be used to simulate actual operations within the facility; e.g., to redirect handoffs and flight data messages from one position to another.

4. *PROBLEM: When the ETG is in use and* the facility changes configuration, data assigned to the display being utilized for ETG purposes cannot be redirected to another display; e.g., facility operating on configuration 1 with position "E" traffic directed to position "S." (Position "E" used for ETG training.) The facility changes to configuration 2, and data for positon "E" must now be rerouted to position "W." ETG must be terminated before the position "E" data can be rerouted to a display other than "S."

RECOMMENDED CHANGE: Modify operational program to allow configuration changes when ETG is in use. Data for the training display will continue to be rerouted as previously selected or may be redirected to another position if the need arises.

5. PROBLEM: Facilities are having a problem simulating handoffs to and from the ARTCC. When a facility is operating in a Radar Data Processing mode, they should have the option of having ETG tracks autoacquire on a "C" position symbol and to simulate handoffs utilizing the "C" position symbol.

RECOMMENDED CHANGE: Modify program to reference site adaptation for the use of position "C" in the ETG program. Allow handoff and auto-acquisition on position symbol "C."

6. *PROBLEM:* The use of the "implied function" is restricted in the ETG program and makes training difficult for new employees and cumbersome for FPL's when they have to change from one system to the other.

RECOMMENDED CHANGE: Restore the implied functions in the ETG program so as to operate the same as the operational program.

7. PROBLEM: Several facilities have indicated a need for a keyboard entry that will cause an aircraft to fly an arc of the radar site.

RECOMMENDED CHANGE: Modify the heading routine of the ETG program to accept a keyboard entry that will cause an aircaft to fly an arc of the radar system the ETG is selected for. The keyboard entry would include a left/right or clockwise/counterclockwise function.

8. PROBLEM: There is a need to reposition active ETG targets. It would be used as a source of targets when a scenario is not available. It would also be used to re-create situations that occurred during a training problem.

RECOMMENDED CHANGE: Implement CCD 4041 (CVGDS-CPT-015).

9. PROBLEM: There is a requirement to simulate loss of ARTS and radar in the training program. The present procedures require the operator to drop all tracks in the ETG system to simulate the failure. The use of the inhibit switches is the best method to simulate the failure, but the data block of an aircraft in "force" status cannot be inhibited.

RECOMMENDED CHANGE: Modify program to accept a keyboard entry to clear the "force" indicator on active ETG tracks and do not set the indicator on future tracks until the force capability has been reinstated.

10. PROBLEM: ARTS III symbology does not include depictions of broadband primary and secondary radar targets.

RECOMMENDED CHANGE: Modify the ARTS System to simulate radar skin paint and beacon control slash. (Hardware modification preferred.)

11. PROBLEM: Objective performance measures are needed in simulation training.

RECOMMENDED CHANGE: Modify the program to permit a keyboard message to be entered to request a printout on the ASR-37 of the time required to complete an ETG problem.

12. PROBLEM: Arriving traffic does not respond to turn instructions in the same way that departing traffic does. Implied turn rates for arivals, therefore, are not appropriate for departures.

RECOMMENDED CHANGE: Implied turn rates should be site variable and discrete for arrivals and departures, to simulate actual traffic.

13. PROBLEM: At the present time, if any manual entry (speed, heading, altitude, etc.) is made on a scenario flight, subsequent scenario events scheduled for that flight are ignored.

RECOMMENDED CHANGE: Basically, the recommendation made was to resolve the problem "in some fashion." One solution recommended later was as follows: If "altitude" is entered manually, further scenario events involving altitude should be ignored. If "speed" is entered manually, further scenario events involving speed should be ignored. If "heading" is entered manually, all further scenario events should be ignored.

14. *PROBLEM:* When a turn (*i.e.*, *a new heading*) is entered, the target instantly enters a turn at the prescribed rate. This is unrealistic. A real aircraft changes from the straight and level attitude to the new attitude gradually.

RECOMMENDED CHANGE: When a heading instruction has been entered, a 3- to 4-second delay should occur before the target starts to turn.

15. PROBLEM: There is a need to be able to quickly and easily generate an ETG target manually.

RECOMMENDED CHANGE: Allow the entry of target ID, followed by SLEW, to generate a target at the slew coordinates, which would reference site-adapted data to determine speed, altitude, and beacon code.

ADDITIONAL SUGGESTIONS.

16. PROBLEM: In controlling live traffic, it is sometimes necessary to "stop departures," either selectively or completely. In ETG, using scenarios, this cannot be accomplished without derogating other scheduled scenario events.

COMMENT: No solution is now apparent.

17. PROBLEM: A means of amending scenario tapes within the facility is needed.

COMMENT: The means to do this, by use of the Magnetic Tape Scenario Maintenance Program (MTSMP) has recently been developed by the Data Systems Staff at San Antonio. The program was delivered to facilities by AAT-550 in March 1978.

18. PROBLEM: A means of producing scenario *tapes within the facility is needed.*

COMMENT: One method of accomplishing this is forthcoming with the distribution of card punch and card reader equipment to ARTS IIIA sites, which will allow local program assembly. Another method is being developed at O'Hare which, if successful, and if it has application at other facilities, will provide a quick and dynamic means of developing a scenario by use of a data extraction routine, thus eliminating the card-to-tape process. In either event, the delays now being experienced in obtaining scenario tapes will be eliminated or reduced to an acceptable level.

19. PROBLEM: A common numbering system of keyboards and displays is needed so that scenarios could be tested at the assembly site.

COMMENT: Scenarios sometimes do not function when they are received from the assembly site, often because a display or keyboard was misidentified. This problem should be alleviated with the advent of scenario assemblies at the individual sites.

20. PROBLEM: There is a need for scenario targets to fly an arc, to make jet penetrations, to make profile descents, and to fly STAR routes.

COMMENT: A specific recommendation has not been developed. It is anticipated that development of the modification described in problem 2 (the "direct" function) might permit programed flights of any description.

21. PROBLEM: It is desirable, but not possible, to allow two positions to operate ETG independently (i.e., so that the tracks of position "A" would not be displayed on position "B").

COMMENT: No specified method of resolving the problem was recommended, and none is immediately apparent.

22. PROBLEM: In preparing scenarios, the initial position of the target can be specified to the nearest whole nautical mile in range. One facility stated a need to be able to specifiy the range to the nearest 1/4 mile.

COMMENT: No specific method of expanding the range coordinate values from whole numbers was recommended.

23. PROBLEM: When training two controllers simultaneously, each on a different display, it would be helpful to be able to freeze one problem without freezing the other.

COMMENT: The desirability of this is obvious at facilities that train two controllers at a time. A preliminary search for a means to accomplish this, however, was unproductive.

APPENDIX D

SUGGESTED SOFTWARE IMPROVEMENTS TO DYSIM

Prepared by
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The following DYSIM software enhancements have been selected, from those requested, as the most beneficial for improving training effectiveness and are, therefore, recommended for immediate implementation. Very little analysis was possible of the potential impact of the change on computer capacity, or of the magnitude of the effort necessary to incorporate the change. Those that have been previously submitted are listed only by name of the change and case file number, others contain a definition of the problem and of the recommended change. Separate NCP's have been prepared for each of the suggested changes not previously submitted to facilitate processing and implementation.

1. Provide a more realistic turn rate and the ability to vary the rate manually.

PROBLEM: When entering a turn, the target responds immediately to the turn, causing unrealistic target performance.

RECOMMENDED CHANGE: Provide a standard turn rate of 2.5° per second with the ability to manually input other rates. Delay initiation of turn so that it does not react immediately. (The 2.5° per second turn rate is now provided in A3d2.6, but manual input of other rates and delayed initiation of turn are not provided.)

2. Provide automatic speed reduction to 250 knots below 10,000 feet (AAT-CPF-018 and ZSEAT-CPF-117C).

3. Provide for the target remaining in automatic mode when altitude change is entered.

PROBLEM: When an altitude change is entered by the controller that changes the altitude to another altitude stratum, the track goes from automatic to manual, which necessitates frequent entries by the pilot.

RECOMMENDED CHANGE: Altitude change will not impact mode of tracking regardless of sector boundaries or altitude stratum.

4. Allow pilot to input indicated airspeed and have computer calculate groundspeed (ZCDDS-CPF-132A).

5. Provide ability to enter weather and wind and restrict operational winds.

PROBLEM: Training for weather conditions cannot be realistically accomplished. Operational winds restrict standardized training.

RECOMMENDED CHANGE: Restrict operational winds and allow DYSIM input of weather and winds to suit training needs.

6. Replace XXX with a one-letter code such as a question mark (ZCDDS-CPF-138).

7. Provide capability for pilot to specify direction of turn.

PROBLEM: Target turns in the direction which causes the least change from the present heading.

RECOMMENDED CHANGE: Change coding of heading field to allow the direction of turn to be specified by the pilot.

8. Provide DYSIM combined sector independence.

PROBLEM: DYSIM is subjected to configuration changes that are made operationally. This impacts training problems.

RECOMMENDED CHANGE: Provide DYSIM with the capability of being unaffected by operational changes in sector configuration.

9. Provide multiple entry capability.

PROBLEM: When a multiple clearance is issued, the pilot must make several entries repeating the aircraft identification each time.

RECOMMEND CHANGE: Provide the capability to enter several commands to the same aircraft with a single identification.

10. Provide the capability to vary climb/descent rates (ZOBDS-CPF-057).

11. Provide handoff capability from training sector to pseudosectors using realistic sector numbers (AAT-14-CPF-013).

12. Provide capability to split a formation flight.

PROBLEM: There is a requirement to control the split of a formation flight, but no provision for providing more than one target at the same position and altitude with a flight plan data base and speed.

RECOMMENDED CHANGE: Provide ability to start additional targets at speed and altitude when a split occurs.

13. Ability to freeze problems.

PROBLEM: DYSIM is a training tool that should provide a means for time-critical counseling and instruction during the administration of instructional problems.

RECOMMENDED CHANGE: Provide the capability to selectively inhibit DYSIM sectors by freezing the current data.

14. Provide for the Simulation category on the pilot's position to be preselected (ZAUSP-CPH-001).

15. Permit the pilot to enter holding instructions prior to the target's reaching the holding fix.

PROBLEM: A future "hold" may be input from the student position at any time, allowing the flight plan data base to be adjusted during the hold. This option is not available from the pilot position, thus requiring the pilot to remember to enter the "hold" command at a later time in the problem, as the target reaches the assigned holding fix. Failure by the pilot to comply with the holding instructions could result in nonstandardized training.

RECOMMENDED CHANGE: Provide a method to input a "hold" message from the pilot position that will put the target in hold, as required, at a future position.

16. Relieve the pilot of having to depress the SIM key for every input.

PROBLEM: The pilot's efficiency is reduced, and his workload increased, by the necessity of depressing the SIM key for every input.

RECOMMENDED CHANGE: Make the SIM key "hot" at pilot positions so that once it is depressed the SIM functions will remain usable until the CLEAR key is depressed. This will allow the pilot to reduce the number of key depressions for each command from the student.

17. Provide a function to permit a DYSIM target to go direct to a fix.

PROBLEM: When a student amends the route of flight to include routing "direct" to a fix, the pilot must plot a heading to that fix, enter the new heading, monitor the target until it reaches the new fix, and then restart the SIM track for the target to resume the automatic mode. This imposes an excessive workload on the pilot during busy periods.

RECOMMENDED CHANGE: Provide coding to allow input from the pilot position to proceed direct to a fix and remain in the automatic mode.