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DEVELOPMENT OF A PRELIMINARY AUTOMATED TOTAL SYSTEMS MODEL FOR --ETC(U)

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20. ABSTRACT (*Continue on reverse side if necessary and identify by block number*)

This report documents the second phase of the multi-phase Integrated Facilities Requirements Study (IFRS).

In Phase I, two analytic submodels were developed. The first, a Logistics Support Requirements Generator, estimates personnel, aircraft, and fuel requirements for each phase of undergraduate pilot training at the Naval Air Training Command (NATRACOM). The second, a Pacing Facilities Requirements sub-

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FOREWORD

This report documents the second phase of the multi-phase Integrated Facilities Requirements Study (IFRS). It has been prepared for the Systems Analysis Division of the Office of the Assistant Commander for Facilities Planning (Code 20), Naval Facilities Engineering Command (NAVFAC), Department of the Navy, as part of Contract N00025-67-C-0031 (NBy-78672) awarded to Operations Research, Inc., in June 1969.

In Phase I, two analytic submodels were developed. The first, a Logistics Support Requirements Generator, estimates personnel, aircraft, and fuel requirements for each training phase. The second, a Pacing Facilities Requirements Submodel, calculates facility requirements for each phase of training.

The purpose of the Phase II study was to develop a preliminary total systems IFRS model (including the two submodels developed in Phase I, as well as base loading, facilities excess/deficiency, and total cost submodels), and automate the model so that it provides quick, accurate, and relevant information for use in the decision-making process. The present IFRS model is working to provide useful information to the decision maker. Refinement and expansion of the present Phase II model will be completed in Phase III.

This report is composed of four volumes. Volume I contains a summary of the IFRS management planning tool. A detailed discussion of each of the five submodels and associated data files is contained in Volume II. A manual discussing the use of the automated model is provided in Volume III and the programmer's manual is contained in Volume IV.

The IFRS model was developed and programmed by staff members of the Economic Analysis Division of Operations Research, Inc., under the direction of Dr. William J. Leininger, Vice President and Division Director, and Thomas N. Kyle, Project Manager. The project team members were Richard D. Heilbron, John H. Avila, Frederick L. McCoy, Thomas L. Shaffer, and Dr. Joan L. Turek.

Mr. Dennis Whang of the Systems Analysis Division of Facilities Planning was contract monitor for NAVFAC. In addition, valuable assistance was provided by many other Navy personnel including, in particular, those in the Office of the Staff Civil Engineer and the Training/Plans Division of the Naval Air Training Command and in the Systems Analysis Division of NAVFAC. The authors gratefully acknowledge the contributions made by all of these people to the development of the IFRS model.

SUMMARY

1. This report documents the second phase of the Integrated Facilities Requirements Study (IFRS). The objective of IFRS is to develop an automated management planning tool for the pilot training program of the Chief of Naval Air Training (CNATRA) that provides the decision maker with quick, accurate, and relevant information required to determine the optimum economic utilization of facilities as a function of the size and composition of the pilot training program.

2. The method employed to achieve this objective was to simulate the Navy's pilot training production process on a time-sharing computer system. The development and automation of the IFRS planning model was directed mainly to providing CNATRA with a flexible management planning tool that will provide rapid answers to a multitude of "What if" questions concerning how postulated changes in the present and future pilot training programs affect personnel, aircraft, and facility requirements; facility utilization; and total systems cost.

3. To enhance its usefulness to the manager, the IFRS model is divided into the five following submodels:

- Logistics Support Requirements Generator
- Base Loading Submodel
- Facilities Requirements Submodel
- Facilities Excess/Deficiency Submodel
- Total Systems Cost Submodel.

These submodels are sequentially related and the output of each is printed by the time-sharing terminal for use by the decision maker as well as automatically entered as input data to one or more successive submodels.

4. The IFRS model is programmed and is currently operational on a time-sharing computer system. The computer programs are written in a conversational mode which permits the decision maker to easily enter his own input data and use the model without a knowledge of the FORTRAN programming language. The use of the automated IFRS planning model by CNATRA staff members can be extremely beneficial to the pilot training program by enhancing effective management in the following ways:

- Provides the Naval Air Training Command (NATRACOM) with an integrated management planning tool that quickly generates timely, accurate, and relevant information for alternative training programs
- Provides a common basis for computing facility requirements, excesses, and deficiencies for pilot training programs by forcing management to define every alternative in the same analytical framework
- Facilitates efficient utilization of excess facilities.
- Provides information useful in the formulation of NATRACOM's Military Construction plans on both an annual basis and over an extended time horizon
- Provides the financial information required to determine which training alternative minimizes total training systems cost
- Frees management from making voluminous routine calculations, giving them more time to manage, analyze, and make decisions
- Permits a larger set of alternatives to be analyzed in greater depth
- Provides the capability to test and analyze consequences of alternatives before making decisions
- Minimizes the risk of making wrong decisions
- Provides rapid answers to questions asked in the daily operations of NATRACOM, budget hearings, and review meetings
- Enhances a smooth transition during the change in management resulting from military personnel transfers.

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I. INTRODUCTION

OBJECTIVE OF THE IFRS STUDY

1.1 The objective of the Integrated Facilities Requirements Study (IFRS) is to develop an automated management planning tool for the pilot training program of the Chief of Naval Air Training (CNATRA) that provides the decision maker with the quick, accurate, and relevant information required to determine the optimum economic utilization of facilities as a function of three key variables:

- Pilot Training Rate (PTR), which is the total number of pilots to be trained in a 1-year period
- MIX of pilot training, which is the PTR divided into the number of jet, propeller (prop), or helicopter (helo) pilots desired
- MODE of pilot training, which includes the syllabus, concepts, and philosophies of the pilot training program.

Optimum economic utilization of facilities describes that pilot training program which yields the most economical total system cost (TSC) to the Naval Air Training Command (NATRACOM). The IFRS model must be capable of providing answers to a multitude of "What if" questions concerning the impact postulated changes in the pilot training program have on personnel, aircraft, and facility requirements; resulting facility excesses or deficiencies; and the total systems cost. These changes in the pilot training program include changes in PTR, MIX, syllabus, location of training phases, training pipeline, training aircraft types, aircraft utilization rate, manning levels, tenants located at each base, etc.

1.2 The IFRS model is programmed on a time-sharing computer system to ensure that these answers are available quickly as required by management.

The IFRS model will enhance the management decision process by automating voluminous routine calculations. Thus, management will be free to spend more time using its creativity and problems solving capability on qualitative analysis and exploring a larger set of alternative training programs under a wide variety of circumstances. As a result, CNATRA management can analyze more alternatives, much faster, more rigorously, and more accurately, with virtually no increase in cost.

1.3 The development of the IFRS model is to be within the general objective of the overall NAVFAC Shore Facilities Planning and Programming System (SFPPS) study[1/] and is to be achieved in several sequential phases, each successive phase being a refinement of the preceding phase and/or an expansion of the model.

Phase I—Development of the Two-Model System

1.4 The purpose of the Phase I study was to develop two analytic submodels. The first was the Logistics Support Requirement (LSR) Generator, which estimates the personnel, aircraft, and fuel requirements for each training phase as a function of the three key input variables of PTR, MIX, and MODE. The second was a Pacing Facilities Requirements List (PFRL)[2/] Submodel developed to calculate the facility requirements for each phase of training as a function of the output of the LSR Generator. Ten facilities were included in this submodel based on their critical importance to the training mission, high cost, or sensitivity to changes in the training program.

Phase II—Development of a Preliminary Total Systems Model

1.5 Following the successful completion of Phase I in December 1968, the scope of the contract was modified to include the development of a preliminary total systems model in Phase II, with refinements to the total systems model to be included in Phase III. In Phase II, the following tasks were to be completed:

- Develop the methodology required to estimate facility requirements by base for the facilities in the PFRL of Phase I and for additional facilities
- Develop the methodology to generate facility excesses and deficiencies by comparing facility requirements with existing facility assets
- Develop the submodel to estimate at least 75 percent of the total system cost (investment plus operations and maintenance) of the pilot training program after costs of military personnel and aircraft acquisition have been deducted

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1/ The SFPPS is a management information system developed to support the total Navy MCON program at the headquarters level, whereas IFRS is a management planning model developed to supplement the management decision process at the command level.

2/ The 10 facilities included in Phase I PFRL are now included in the Facilities Requirements Submodel.

- Program the LSR Generator of Phase I and all Phase II submodels on a time-sharing computer system so that the IFRS can be easily used by NATRACOM personnel.

The accomplishments of Phase II of the IFRS study are discussed in this report.

Phase III—Completion of the Total Systems Model

1.6 In Phase III, the total IFRS model is to be refined to the extent that the model estimates between 85 and 90 percent of the actual total systems cost[3/] of the pilot training program. In addition, an optimization search algorithm which will minimize cost for a given performance level or maximize performance for a given cost will be developed as a subroutine of the computerized total systems model. A recommended scope for Phase III is included in Section III of this report.

Following Phases

1.7 Subsequent phases will develop similar IFRS management planning models for the Chief of Naval Air Technical Training (CNATECHTRA) and for the Chief of Naval Air Reserve Training (CNARESTRA), Carrier Readiness Air Wings, and fleet air commands. Other possible extensions of the analytic approach are currently being explored in the areas of maintenance management and limited portions of master planning.

STUDY PRODUCT

1.8 The end product of the IFRS will be an operating system that will enable NATRACOM to determine quickly the total physical and monetary resources for men, aircraft, fuel, and facilities required to achieve a specified PTR, MIX, and MODE. The IFRS model will also show how these resource requirements change as a function of changes in the pilot training program. Moreover, the IFRS model has the additional capability of computing the number of pilots that can be trained (i.e., PTR) given a limited supply of aircraft, enlisted personnel, and instructors. Thus, the IFRS model can calculate either the amount of resources required to achieve a desired PTR or the PTR that can be achieved with a given amount of resources. The emphasis of the IFRS is on facilities, but to accurately predict facility requirements, excesses, and deficiencies, the men and aircraft that constitute the base loading must be estimated. Thus, the IFRS includes estimates of all resources utilized in the pilot training production process.

USER OF THE IFRS MODEL

1.9 Members of CNATRA's staff are continuously evaluating the pilot training program to determine what would happen if certain changes occurred. Generally, a major change in the pilot training program will have cascading effect throughout the operating structure of CNATRA. For example, if the annual number of pilots programmed to be trained (PTR) is to be either increased or decreased, the Training/Plans Division must determine how these postulated changes in

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[3/] Exclusive of the cost of military personnel and aircraft acquisitions.

the PTR will affect the resource requirements of personnel, aircraft, and fuel for each training phase. Concurrently, the Staff Civil Engineer must determine how these changes affect the facility requirements and utilization at all bases currently conducting pilot training. The personnel officer must know what effect these changes have on manpower staffing levels at the bases; the financial officer must determine how this change affects future budgets, etc.

1.10 The emphasis of the IFRS model is on facilities, and thus the initial user of the IFRS model will be the members of CNATRA's Staff Civil Engineering Section[4/] who are responsible for the facilities management at the bases currently conducting pilot training. The personnel in the Training/Plans Division will provide key inputs to the IFRS by specifying the PTR, MIX, and MODE of each alternative training program.

1.11 An automated management tool such as the IFRS model can be extremely beneficial in the enhancement of effective management, for it provides quick, accurate, and relevant answers to questions asked by management. The significant contributions of the present study are discussed in the following subsection.

SIGNIFICANT CONTRIBUTIONS OF THE IFRS STUDY

1.12 The method employed to achieve the objective of the study was to simulate the pilot training production process on a time-sharing computer system. The simulation methodology essentially replicates the existing NATRACOM planning process, and its flexibility provides the CNATRA staff with a powerful tool for analyzing a multitude of training alternatives.

1.13 The use of the IFRS model will contribute to better management of the pilot training program in the following ways:

- Provides NATRACOM with an integrated management planning tool that generates timely, accurate, and relevant information for alternative training programs
- Provides a common basis for computing facility requirements, excesses, and deficiencies for the eight pilot training bases
- Provides information useful in the formulation of NATRACOM's Military Construction (MCON) plans on both an annual and an extended time period basis
- Provides the financial information required to determine which training alternative minimizes total training systems cost
- Facilitates efficient utilization of excess facilities

4/ Additionally, personnel in the Aviation Training Office of the Chief of Naval Operations are currently using the IFRS model.

- Provides information that assists management in determining the optimum location of training phases among existing bases
- Frees management from making extensive routine calculations,giving them more time to manage, analyze, and make decisions.

1.14 The common unit of measure for all resources is dollars, and thus, the estimate of the total cost resulting from a "What if" question is the primary measure of the relative worth of an alternative, assuming the quality of a pilot's training is not compromised. The staff can evaluate the training program either by determining the least total systems cost for a given performance level, or, by determining the maximum performance level achievable for a given total systems cost.

SATISFACTION OF CONTRACTUAL REQUIREMENTS

1.15 The terms and conditions of the contract required ORI to complete particular tasks and milestones in this second phase of the IFRS model development. The following listing, which associates various Phase II activities and end products with the task statement fulfilled by that portion, provides the best indication of satisfaction of contractual obligations.

1.16 Systems Orientation. The bibliography in Appendix M presents a list of the documents reviewed in Phase II.

1.17 Data Collection. The data sources for the eight NATRACOM activities are noted in Volume II. The cost estimating relationships are documented in Appendix I, "Total Systems Cost Submodel." The current state of facilities is included in Appendix F, "Assets Position Data File." The ranges of the control variables appear as required in the various appendices. Appropriate data working forms appear throughout Volume II.

1.18 Model Development. The Base Loading, Facilities Requirements, Excess/Deficiency, and Total Systems Cost Submodels were developed as discussed in their respective appendices in Volume II. These submodels incorporate total base loading by accounting for activity and facility user relationships. The method available to obtain an estimate of 100 percent facility investment cost appears in Appendix I.

1.19 Systems Programming. The LSR Generator, Base Loading, Facilities Requirements, Excess/Deficiency, and Total Systems Cost Submodels and associated data files were programmed, tested, and debugged as shown in Volume IV, "Programmer's Manual." The Performance Submodel was not programmed separately, since the flexibility built into the other submodels permits analysis of the performance variables.

1.20 Installation of Time-Sharing Computer Terminal. A time-sharing terminal was installed in the CNATRA headquarters building from mid-October through December. ORI personnel assisted NATRACOM personnel in the use and operation of the computer and programs during this period.

1.21 Total Systems Model Demonstration. The computerized IFRS simulation model was demonstrated to NATRACOM and NAVFAC personnel during December and January. The results of the sensitivity analyses and the testing of the single base concept performed under this task statement are shown in Appendix L.

1.22 Documentation. Volumes I, II, III, and IV provide the specified documentation. The recommended Phase III scope appears in Section III of Volume I.

ORGANIZATION OF REPORT

1.23 Volume I of this report presents a summary of the IFRS model developed in Phase II. Section II includes a brief description of each of the five computerized submodels included in the IFRS model, including a discussion of inputs, methodology, outputs, and sample computer printouts of each and a discussion of the flexibility built into the model. Section III highlights the conclusions and recommendations of the Phase II study, including a discussion of the benefits that CNATRA can derive from the use of IFRS model, and discusses the limitations of the model. A recommended scope for the Phase III study also appears in Section III.

1.24 Volume II of this report contains a detailed discussion of each of the submodels and data files of the IFRS model, as well as a discussion of the runway methodology employed, the results of the sensitivity analysis, a discussion of the Government-developed performance model, and a bibliography.

1.25 Volume III contains the User's Manual which describes how to use the various IFRS programs.

1.26 Volume IV contains the Programmer's Manual, including program descriptions, flow charts, variable dictionaries, routine dictionaries, and program listings.

II. OVERVIEW OF THE IFRS MANAGEMENT PLANNING MODEL

INTRODUCTION

2.1 The IFRS model essentially replicates NATRACOM's present planning methodology by simulating the pilot training system on a time-sharing computer. The decision maker's primary inputs to the IFRS are the PTR/MIX and the location of each training phase.

2.2 The Phase II IFRS model is in a preliminary state, since additional refinements are required on certain planning equations, data files, and computer printouts. These refinements are to be undertaken in Phase III. However, the logic of the model is correct and accurate, and the output of the model can provide the CNATRA staff with relevant planning information.

2.3 With the use of a remote time-sharing computer terminal at the manager's desk, the IFRS can generate this planning information within an hour or less. Flexibility was built into the IFRS model to ensure its continued usefulness as a management planning tool. The model is extremely easy to operate and is programmed in a conversational mode which permits the decision maker to enter his own relevant information throughout the entire operation of the model. The user need not be familiar with the FORTRAN programming language, since the computer queries the operator in English when it needs specific inputs. To enhance its usefulness to the manager, the computerized IFRS model was divided into the five following submodels:

- Logistics Support Requirements (LSR) Generator
- Base Loading Submodel
- Facilities Requirements Submodel

- Excess/Deficiency Submodel
- Total Systems Cost (TSC) Submodel.

IFRS submodels are shown in the simulation flow chart in Figure 2.1. The output of each submodel is printed at the time-sharing terminal as well as automatically entered to one or more successive submodels. The following subsections include a discussion of the present pilot training system and each of the IFRS submodels and data files.

PILOT TRAINING SYSTEM

2.4 NATRACOM's pilot training program consists of a series of separate but related training phases. Each phase is defined by a training syllabus which specifies a combination of flight and academic requirements that a student must successfully complete prior to proceeding to the next phase. A student's pilot training skills and capability are assumed to increase at each phase until he graduates as a qualified pilot.

2.5 The path that students follow from one phase to another is called the pipeline. The particular sequence of phases that a student passes through (i.e., the specific pipeline) is a function of two variables: The background (source) of the student at the time he enters the pipeline (i.e., Navy Officer, Navy Aviation Officer Candidate (AOC), Marine, Coast Guard, or foreign student) and the type of pilot desired (i.e., jet, prop, or helo). This variability of curriculum occurs since the amount of training required by a student is a function of his background and also a function of the type of pilot he will be when he graduates. The present 14-phase pilot training pipeline is illustrated in Figure 2.2.

AUTOMATED IFRS SUBMODELS

Logistics Support Requirements (LSR) Generator

2.6 The purpose of the LSR Generator is to calculate the total personnel, aircraft, and fuel required to conduct a training phase independent of a specific location.

2.7 Input. There are several basic inputs to the LSR Generator. Initially, the following planning factors that define each phase of training are entered for each phase.

- Name of phase
- Estimated point at which students attrite
- Length of the phase in weeks
- Tour of duty of flight instructors

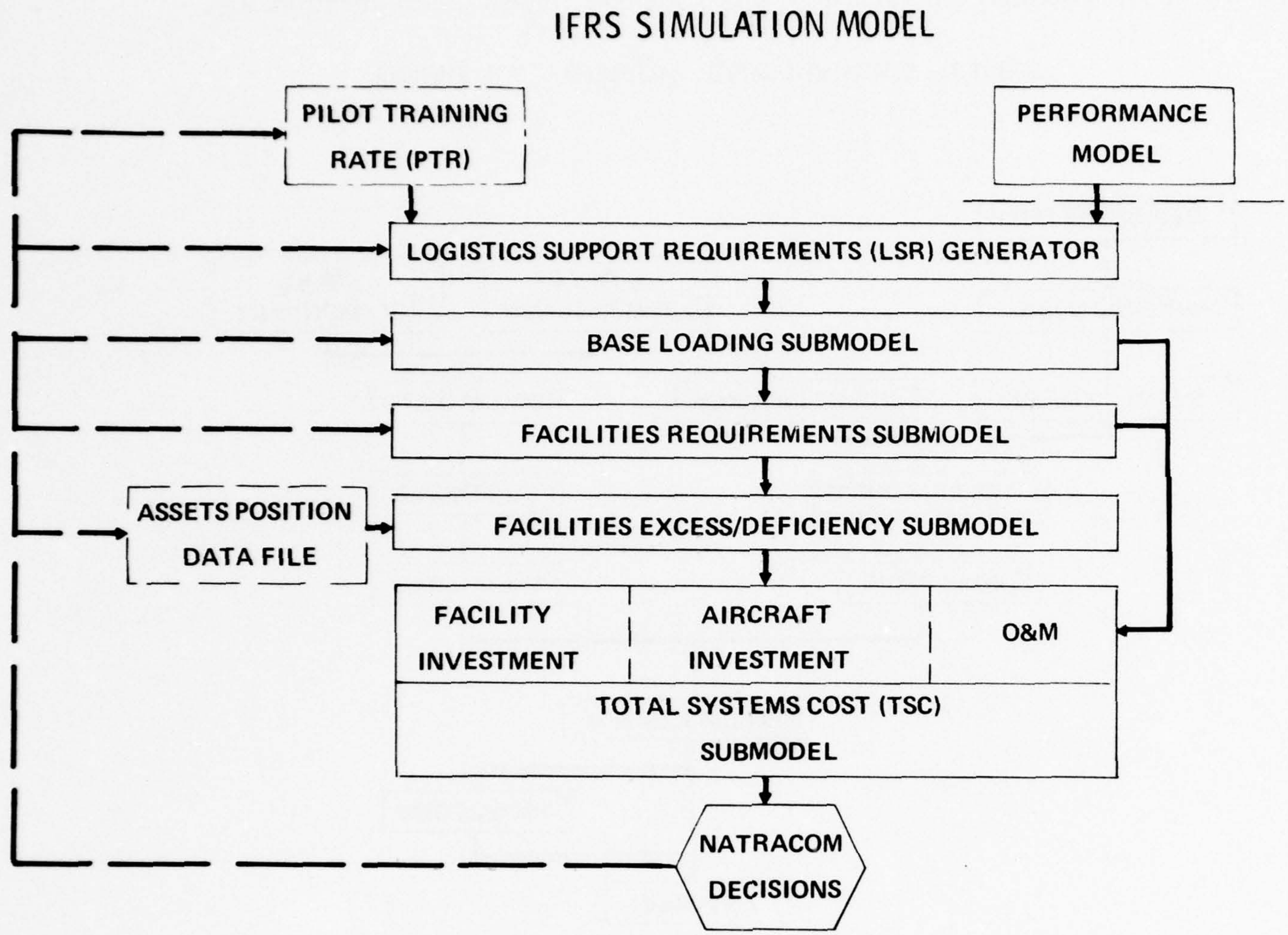

FIGURE 2.1. IFRS SIMULATION MODEL

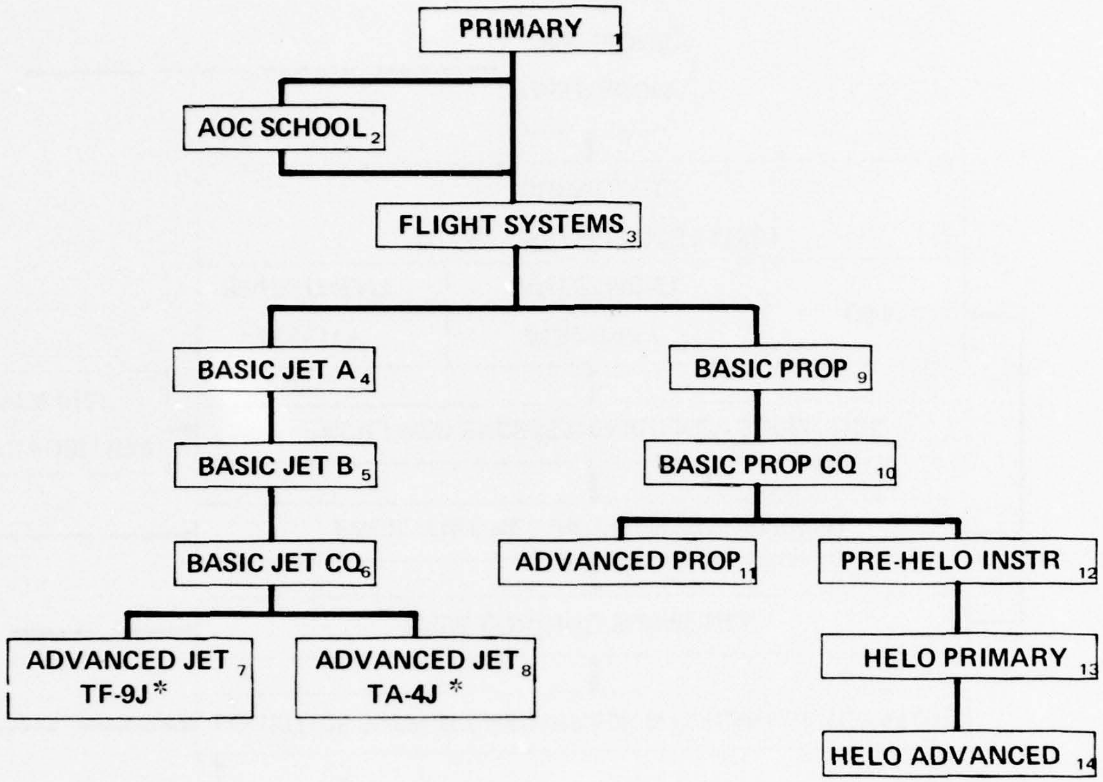

FIGURE 2.2. CURRENT PILOT TRAINING PIPELINE

*For purposes of the model, two advanced jet phases are included since two types of aircraft are now in use.

- Number and type(s) of aircraft used in the phase
- Type of fuel consumed and consumption rate for the above aircraft
- Aircraft utilization assuming perfect weather
- Flight instructor utilization assuming perfect weather
- Flyable weather (percent of time a scheduled mission is flown)
- Aircraft flight hours required per student output, including overhead hours
- The number of students supported by one landing support officer (LSO) for phases utilizing the aircraft carrier
- The number of maintenance men required per aircraft
- Flight instructor training period or the number of months required to train a new instructor.

A computer listing of the planning factor data currently stored in the program for the Basic Prop Carrier Qualification (CQ) phase appears in Table 2.1.

2.8 The next input is the pipeline, or the sequence in which a student passes through the phases, and the student attrition rate associated with each student source. The above data are permanently stored in the computer until the decision maker wants to change the planning factors, training phase, pipeline, or attrition rate. Consequently, it is not necessary to re-enter these data each time the model is used. Next he enters the number of training weeks per year and the number of annual flying days per year for the pilot training program. Finally, he enters the PTR/MIX (i.e., the total number of jet, prop, and helo pilots to be graduated each year) by source of student. These data appear in Table 2.2 for a hypothetical 2,510 PTR.

2.9 General Methodology. The methodology used in the LSR Generator replicates that currently used by CNATRA's staff. The basic methodology of the LSR Generator was developed in Phase I and modified in Phase II to account for the different pipelines followed by students with different backgrounds (i.e., from different sources).

2.10 The model calculates the student input and output for each phase of training and for each student source based on student attrition rates associated with the student source. The model starts at the bottom of the pipeline and calculates the student inputs for the advanced jet, prop, and helo phases for each student source based on the student output, which is the PTR initially

TABLE 2.1

SAMPLE PLANNING FACTORS ENTERED TO DEFINE THE BASIC PROP CQ PHASE OF TRAINING*

DATA LIST FOR TRAINING PHASE 10

01	PHASE NAME	B-PROP CQ
02	ATTRITION POINT	0.5000
03	PHASE DURATION	4.00 WEEKS
04	TOUR OF DUTY	24.00 MONTHS
05	AIRCRAFT TYPES	1
06	INSTRUCTION TYPES	0**
07	AIRCRAFT TYPES	T28C
08	FUEL TYPE	AGAS
09	FLYABLE WEATHER	0.879
10	FUEL CONSUMPTION	50.50
11	A/C UTILIZATION	2.81
12	INSTRUCTOR UTIL.	2.22
13	FLIGHT HOURS	15.00
14	FLIGHT INST. HOURS	6.60
15	INST. TR. PERIOD	2.00
16	LSO RATIO	10.00
17	MAINTENANCE MEN	5.47

* Underline indicates an input by decision maker.

** Academic instructors are not assigned to phases, and thus their requirement is excluded from the LSR Generator.

TABLE 2.2

SAMPLE INPUT DATA FOR LSR GENERATOR

(PILOT TRAINING RATE = 2510)

STUDENT SOURCE	PTR AND MIX		
	JET	PROP	HELO
NAVY – OFFICERS	345	410	100
– AOC	345	500	150
MARINES	275	–	285
COAST GUARD/FOREIGN	–	40	60
TOTAL	965	950	595

entered by the decision maker. Since the student inputs to the advanced phases are the same as the student outputs of the preceding phases (i.e., those flowing into the advanced phases), the student inputs to the preceding phases can be calculated. This process is repeated until the student output and input for each phase of training and each student source are calculated. Next, the model sums the student input and output over all sources of students for each phase. Finally, the model calculates the average student load and resource requirements for each phase of training. The IFRS Phase I report and Appendix B of Volume II contain a detailed discussion of the LSR Generator methodology and assumptions made.

2.11 Output. The output of the LSR Generator consists of the student input, student output, and number of attrites by phase and source of student. The remaining output is phase specific in that it is the total required for each phase of training without reference to student source. This output includes the following data:

- Average student load or average number of students in each phase throughout the year
- Number of flight instructors, flight instructors under training, and landing support officers required
- Number of administrative officers, including both aviators and nonflying officers
- Total number of officers (the sum of the two previous items)
- Total enlisted aircraft maintenance men, including enlisted administrative personnel
- Number of aircraft required by type
- Amount of fuel required by type
- Runway requirements, assuming perfect wind conditions
- Airspace saturation factor (the ratio of total aircraft in an airspace to the maximum number of aircraft permissible in the airspace)
- Outlying landing field (OLF) requirements
- Air to ground target areas.

These outputs are printed by phase for the decision maker. In addition to the preceding outputs, the total annual aircraft flight hours are also stored in the computer for use as input data to the Base Loading Submodel.

2.12 The outputs from the LSR Generator are calculated in a matter of minutes at the time-sharing terminal. Management can quickly see how a change in the PTR affects the resources required by each training phase. Thus, when someone wants to know how many aircraft by type would be required for a specific PTR/MIX, that particular answer plus other planning information are available within a few minutes.

2.13 Illustrative Example. For an annual PTR of 2510, Tables 2.3 through 2.6 provide sample computer printouts illustrating the pipeline, the inputs required, and the student statistics for each student source. These data for students who are already Navy Officers (i.e., student source) are shown in Table 2.3. The pipeline for Navy Officers, as defined by NATRACOM and entered by the decision maker, is shown at the top of Table 2.3. All students begin with Phase 1, Primary, skip Phase 2, AOC School (since they are commissioned Navy officers), and proceed to Phase 3, or Flight Systems. The phases are numbered by the model and the decision maker defines the pipeline by simply specifying the number of the following phase or phases as shown in the right-hand column. By definition, advanced training phases require no following phases, as noted. At this point in the pipeline, a distinction between jet and prop/helo students is made. The students who successfully complete Flight Systems enter either the jet branch of the pipeline, Phase 4, or the prop/helo branch, Phase 9. The number going to each branch is specified in conjunction with the PTR. The jet students progress from Basic Jet A, to Basic Jet B, and then to Advanced Jet with either the TF-9J or TA-4J[1/] aircraft. The prop students progress from Basic Prop to the Basic Prop Carrier Qualification phase. At this point these students enter either Advanced Prop, Phase 11, or Pre-Helo, Phase 12. The helo students then progress to Helo Primary and finally to the Helo Advanced phase. Once these data are entered, they are permanently stored in the computer until modification is desired.

2.14 The decision maker must enter the data shown in the center of Table 2.3 each time he uses the model. First, he specifies the number of training weeks and annual flying days per year for all students types. The current NATRACOM factors are 50 training weeks and 245 training days per year. The PTR desired for each advanced phase for the Navy Officer pipeline is then specified. The 345 total PTR for Advanced Jet was divided between Phase 7, with the TF-9J aircraft, and Phase 8, with the TA-4J aircraft. The 410 student output for Phase 11, Advanced Prop, and the 100 student output for Phase 14, Advanced Helo, are typed into the time-sharing terminal. Having completed the above, the decision maker need make no additional inputs for Navy Officers.

1/ For purposes of the model, two advanced jet phases are included since two types of aircraft are now in use. When all TF-9Js have been phased out, Phase 7 will be deleted and all succeeding phases will be renumbered.

TABLE 2.3

PIPELINE, INPUTS, AND STUDENT STATISTICS FOR NAVY OFFICER STUDENTS

- PIPELINE

TRAINING PIPELINE FOR NAVY OFFICER

PHASE NO.	PHASE NAME	ATTRITION RATE	FOLLOWING PHASES
1	PRIMARY	0.0900	3
3	FLIGHT SYS.	0.0270	4, 9
4	BASIC JET-A	0.0500	5
5	BASIC JET-B	0.0200	6
6	B-JET G/CQ	0.0200	7, 8
7	ADV JET-TF	0.0400	
8	ADV JET-TA	0.0400	
9	BASIC PROP	0.1400	10
10	B-PROP CQ	0.0040	11,12
11	ADV PROP	0.0080	
12	PRE HELO	0.0050	13
13	HELO PRIM	0.0020	14
14	HELO ADV	0.0020	

- INPUT

ENTER TRAINING WEEKS PER YEAR
AND ANNUAL FLY-DAYS (XX.,XXX.)?50,245

FOR PIPELINE NAVY OFFICER
ENTER PHASE NUMBER AND STUDENT OUTPUT (XX,XXXX.)
PHASE 0,0 IMPLIES NO FURTHER ASSIGNMENTS?7,172

NEXT?8,173

NEXT?11,410

NEXT?14,100

NEXT?0,0

- STUDENT STATISTICS

STUDENT TYPE NAVY OFFICER

TRAINING PHASE	.STUDENT INPUT	STATISTICS. OUTPUT	ATTRITES
PRIMARY	1123.	1022.	101.
FLIGHT SYS.	1022.	994.	28.
BASIC JET-A	394.	374.	20.
BASIC JET-B	374.	367.	7.
B-JET G/CQ	367.	359.	7.
ADV JET-TF	179.	172.	7.
ADV JET-TA	180.	173.	7.
BASIC PROP	600.	516.	84.
B-PROP CQ	516.	514.	2.
ADV PROP	413.	410.	3.
PRE HELO	101.	100.	1.
HELO PRIM	100.	100.	0.
HELO ADV	100.	100.	0.

TABLE 2.4

PIPELINE, INPUTS, AND STUDENT STATISTICS FOR NAVY AOC STUDENTS

- PIPELINE

TRAINING PIPELINE FOR NAVY - AOC

PHASE NO.	PHASE NAME	ATTRITION RATE	FOLLOWING PHASES
1	PRIMARY	0.1400	2
2	AOC SCHOOL	0.0730	3
3	FLIGHT SYS.	0.0320	4, 9
4	BASIC JET-A	0.0800	5
5	BASIC JET-B	0.0310	6
6	B-JET G/CQ	0.0160	7, 8
7	ADV JET-TF	0.0520	
8	ADV JET-TA	0.0520	
9	BASIC PROP	0.2400	10
10	B-PROP CQ	0.0060	11, 12
11	ADV PROP	0.0120	
12	PRE HELO	0.0060	13
13	HELO PRIM	0.0050	14
14	HELO ADV	0.0050	

- INPUT

```
FOR PIPELINE NAVY - AOC
ENTER PHASE NUMBER AND STUDENT OUTPUT (XX,XXXX.)
PHASE 0,0 IMPLIES NO FURTHER ASSIGNMENTS?7,173

NEXT?8,172

NEXT?11,500

NEXT?14,150

NEXT?0,0
```

- STUDENT STATISTICS

STUDENT TYPE NAVY - AOC

TRAINING PHASE	.STUDENT INPUT	STATISTICS. OUTPUT	ATTRITES
PRIMARY	1667.	1434.	233.
AOC SCHOOL	1434.	1329.	105.
FLIGHT SYS.	1329.	1287.	43.
BASIC JET-A	415.	382.	33.
BASIC JET-B	382.	370.	12.
B-JET G/CQ	370.	364.	6.
ADV JET-TF	182.	173.	9.
ADV JET-TA	181.	172.	9.
BASIC PROP	872.	662.	209.
B-PROP CQ	662.	658.	4.
ADV PROP	506.	500.	6.
PRE HELO	152.	152.	1.
HELO PRIM	152.	151.	1.
HELO ADV	151.	150.	1.

TABLE 2.5

PIPELINE, INPUTS, AND STUDENT STATISTICS FOR MARINE STUDENTS

• PIPELINE

TRAINING PIPELINE FOR MARINE

PHASE NO.	PHASE NAME	ATTRITION RATE	FOLLOWING PHASES
1	PRIMARY	0.0500	3
3	FLIGHT SYS.	0.0150	4, 9
4	BASIC JET-A	0.0400	5
5	BASIC JET-B	0.0100	6
6	B-JET G/CQ	0.0100	7, 8
7	ADV JET-TF	0.0300	
8	ADV JET-TA	0.0300	
9	BASIC PROP	0.0900	10
10	B-PROP CQ	0.0050	12
12	PRE HELO	0.0040	13
13	HELO PRIM	0.0020	14
14	HELO ADV	0.0020	

• INPUT

```
FOR PIPELINE MARINE
ENTER PHASE NUMBER AND STUDENT OUTPUT (XX,XXXX.)
PHASE 0,0 IMPLIES NO FURTHER ASSIGNMENTS?7,137

NEXT?8,138

NEXT?14,285

NEXT?0,0
```

• STUDENT STATISTICS

STUDENT TYPE MARINE

TRAINING PHASE	.STUDENT INPUT	STATISTICS. OUTPUT	ATTRITES
PRIMARY	661.	628.	33.
FLIGHT SYS.	628.	619.	9.
BASIC JET-A	301.	289.	12.
BASIC JET-B	289.	286.	3.
B-JET G/CQ	286.	284.	3.
ADV JET-TF	141.	137.	4.
ADV JET-TA	142.	138.	4.
BASIC PROP	317.	289.	29.
B-PROP CQ	289.	287.	1.
PRE HELO	287.	286.	1.
HELO PRIM	286.	286.	1.
HELO ADV	286.	285.	1.

TABLE 2.6

PIPELINE, INPUTS, AND STUDENT STATISTICS FOR COAST GUARD/FOREIGN STUDENTS

- PIPELINE

TRAINING PIPELINE FOR C-GRD & FOR.

PHASE NO.	PHASE NAME	ATTRITION RATE	FOLLOWING PHASES
1	PRIMARY	0.0500	3
3	FLIGHT SYS.	0.0200	9
9	BASIC PROP	0.0500	11,12
11	ADV PROP	0.	
12	PRE HELO	0.	13
13	HELO PRIM	0.	14
14	HELO ADV	0.0100	

- INPUT

```
FOR PIPELINE C-GRD & FOR.
ENTER PHASE NUMBER AND STUDENT OUTPUT (XX,XXXX.)
PHASE 0,0 IMPLIES NO FURTHER ASSIGNMENTS?11,40

NEXT?14,60

NEXT?0,0
```

- STUDENT STATISTICS

STUDENT TYPE C-GRD & FOR.

TRAINING PHASE	.STUDENT INPUT	STATISTICS. OUTPUT	ATTRITES
PRIMARY	114.	108.	6.
FLIGHT SYS.	108.	106.	2.
BASIC PROP	106.	101.	5.
ADV PROP	40.	40.	0.
PRE HELO	61.	61.	0.
HELO PRIM	61.	61.	0.
HELO ADV	61.	60.	1.

2.15 From these inputs, the computer program calculates the student statistics of input, output, and attrites by phase, as shown at the bottom of Table 2.3. Note that the output of the advanced phases is exactly the PTR entered above. Furthermore, the output of each phase is equal to the input to the following phases, as specified above, e.g., the 514 student output from Basic Prop CQ equals the sum of the student input of 413 for Advanced Prop and 101 for Pre-Helo.

2.16 Similar data are shown for NAVY AOC students in Table 2.4. However, in this pipeline the attrition rates are different from those for Navy Officers, and all AOC students must progress through Phase 2, AOC School.

2.17 The Marine students pipeline consists of 12 phases since these students skip Phase 2, AOC School, and Phase 11, Advanced Prop, as shown in Table 2.5. Consequently, the entire Marine student output from the Basic Prop CQ phase is input to the Pre-Helo phase.

2.18 The Coast Guard and foreign students skip AOC School and the entire jet branch of the pipeline as shown in Table 2.6. Thus, the input data are the student output desired from the Advanced Prop and Advanced Helo phases.

2.19 After all the pipelines and PTRs have been specified as in Tables 2.3 through 2.6, the LSR Generator calculates the resources required to meet the selected PTR. It sums the student statistics for all students by phase, as shown in Table 2.7. From this, it can be seen that to train 2,510 pilots in a year, 3,565 students must enter the pilot training program each year. The following numbers are required from each student source:

1,123 Navy officers
1,667 Navy AOCs
661 Marines
114 Coast Guard/foreign.

2.20 Next, the IFRS model calculates detailed personnel, aircraft, and fuel requirements for all training phases in the pipeline, as shown in the printout for the Basic Prop CQ phase in Table 2.8. It can be seen that to train 2,510 pilots per year in the specified MIX, 36 T-28C aircraft, 20 flight instructors, 12 landing support officers, 238 enlisted men, etc., are required for this one phase, Basic Prop CQ.

2.21 If the decision maker desires, he may request the summary data for all phases of training, as shown in Table 2.9. These data are the average requirements based on the present training syllabus. Each of these items was described previously in paragraph 2.11.

2.22 Additional information calculated by the LSR Generator includes airspace saturation factors and requirements for runways, air-to-ground target areas, and OLFs, as shown in the sample printout in Table 2.10. The effective runway requirements are based on perfect wind conditions. The runway requirements shown may be low, since an accelerated launch/recovery cycle is currently used in the

TABLE 2.7

STUDENT STATISTICS FOR ALL STUDENTS

TOTAL FOR ALL STUDENT TYPES

TRAINING PHASE	•STUDENT INPUT	OUTPUT	STATISTICS• ATTRITES
PRIMARY	3565•	3192•	373•
AOC SCHOOL	1434•	1329•	105•
FLIGHT SYS•	3087•	3005•	82•
BASIC JET-A	1110•	1045•	65•
BASIC JET-B	1045•	1023•	22•
B-JET G/CQ	1023•	1007•	16•
ADV JET-TF	503•	482•	21•
ADV JET-TA	504•	483•	21•
BASIC PROP	1895•	1568•	327•
B-PROP CQ	1467•	1460•	7•
ADV PROP	959•	950•	9•
PRE HELO	601•	599•	3•
HELO PRIM	599•	597•	2•
HELO ADV	597•	595•	2•

TABLE 2.8

SAMPLE DETAIL LSR GENERATOR PRINTOUT

```
NAME OF PHASE B-PROP CQ
STUDENT INPUT 1467•
STUDENT OUTPUT 1460•
AVERAGE STUDENT LOAD  117•
ADMINISTRATIVE OFFICERS   12•
TOTAL OFFICERS   45•
TOTAL ENLISTED  238•
AIRCRAFT TYPES          T28C
NUMBER REQUIRED          36•
FUEL TYPES              AGAS
GALLONS CONSUMED   0•111E+07*
FLIGHT INSTRUCTORS       20•
UNDER TRAINING            2•
LSO REQUIREMENTS         12•
ENLISTED SUPPORT        238•
```

* $.111 \times 10^7$ or 1,110,000 gallons.

TABLE 2.9

SAMPLE LSR GENERATOR SUMMARY PRINTOUT

TRAINING PHASE	STUDENT LOAD	AIRCRAFT TYPE	AIRCRAFT NO.	FUEL TYPE	CONSUMED GALLONS	TOTAL OFF	TOTAL ENL
PRIMARY	405.	T34B	129.	AGAS	0.131E+07	199.	379.
AOC SCHOOL	276.		0.		0.	8.	0.
FLIGHT SYS.	305.		0.		0.	9.	0.
BASIC JET-A	237.	T-2A	97.	JP-4	0.212E+08	159.	585.
BASIC JET-B	186.	T2BC	101.	JP-4	0.240E+08	133.	795.
B-JET G/CQ	142.	T2BC	58.	JP-4	0.113E+08	76.	493.
ADV JET-TF	197.	TF9J	170.	JP-4	0.589E+08	214.	1378.
ADV JET-TA	197.	TA4J	153.	JP-4	0.468E+08	210.	1264.
BASIC PROP	658.	T28C	283.	AGAS	0.101E+08	323.	1347.
B-PROP CQ	117.	T28C	36.	AGAS	0.111E+07	45.	238.
ADV PROP	325.	TS2A	164.	A115	0.125E+08	257.	1599.
PRE HELO	60.	T28C	18.	AGAS	0.710E+06	29.	102.
HELO PRIM	48.	TH57	21.	AGAS	0.182E+06	31.	77.
HELO ADV	95.	THIL	54.	JP-4	0.339E+07	82.	372.

TABLE 2.10

SAMPLE AIRCRAFT RELATED LSR GENERATOR PRINTOUT

TRAINING PHASE	A/C TYPE	EFFECTIVE RUNWAYS	AIRSPACE SATURATIØN	ØLF	TARGET AREAS
PRIMARY	T34B	1.077	0.649	0.497	0.
BASIC JET-A	T-2A	0.823	0.823	0.369	0.
BASIC JET-B	T2BC	0.644	0.644	0.289	0.
B-JET G/CQ	T2BC	0.514	0.514	0.198	0.
ADV JET-TF	TF9J	1.520	0.168	0.524	0.
ADV JET-TA	TA4J	1.524	0.169	0.525	0.
BASIC PRØP	T28C	1.313	0.437	0.685	0.
B-PRØP CQ	T28C	0.301	0.010	0.217	0.
ADV PRØP	TS2A	1.357	0.335	0.431	0.
PRE HELØ	T28C	0.144	0.009	0.064	0.
HELØ PRIM	TH57	0.452	0.452	0.114	0.
HELØ ADV	THIL	0.508	0.508	0.113	0.

model. The airspace saturation factor is the ratio of total aircraft in the air at a time divided by the number of aircraft required to saturate the airspace. Thus, for the T-34B aircraft, only 60.3 percent of the allocated airspace is used at any time. The OLF requirements shown are low due to lack of adequate planning factors. The model has the capability to estimate air-to-ground target areas; however, data for estimating these were not available.

Base Loading Submodel

2.23 The purpose of the Base Loading Submodel is to convert all phase specific output of the LSR Generator to base specific data and calculate the total personnel, aircraft, and fuel requirements of each base.

2.24 Input. The user types the base location of each training phase into the time-sharing terminal. The flexibility of the computer program permits the decision maker to assign one or more phases or parts of a phase to nine bases (the eight existing pilot training bases plus a completely new base). A recommended starting point is the phase to base assignment schedule currently in use by NATRACOM shown in Table 2.11.

2.25 At present, an entire training phase is assigned to a naval air station (NAS). For instance, NAS Meridian has two complete phases, Basic Jet A and Basic Jet B. Other data inputs to this submodel include:

- All training phase data calculated in the LSR Generator
- Number of tenant personnel assigned to each NAS (stored in the Base Data File)
- Number of tenant and NAS aircraft located at each NAS (stored in the Base Data File).

2.26 General Methodology. This submodel assigns all training phase data developed in the LSR Generator to one or more bases as a function of the phase to base assignment schedule typed in by the decision maker. Next, it sums the number of tenant personnel assigned to each base and the training phase personnel assigned to obtain the total personnel supported by the NAS. From this information, the model estimates the total NAS personnel required to support the training phase and tenants at each base. 2/ The submodel also adds the number of tenant and NAS aircraft to the training phase aircraft and then estimates the fuel consumption of the tenant and NAS aircraft. Additional information on the methodology and assumptions made in this submodel appears in Appendix C of Volume II.

2/ The equations for estimating NAS personnel were developed from the existing NAS base loading data for the eight existing pilot training bases.

TABLE 2.11

CURRENT NATRACOM PHASE TO BASE ASSIGNMENT SCHEDULE*

Phase		NAS	Amount
1	Primary	Saufley	1.0
2	AOC School	Pensacola	1.0
3	Flight Systems	Pensacola	1.0
4	Basic Jet A	Meridian	1.0
5	Basic Jet B	Meridian	1.0
6	Basic Jet CO	Pensacola	1.0
7	Adv Jet	Kingsville	1.0
8	Adv Jet	Chase	1.0
9	Basic Prop	Whiting	1.0
10	Basic Prop CO	Saufley	1.0
11	Adv Prop	Corpus Christi	1.0
12	Pre-Helo	Pensacola	1.0
13	Helo Primary	Ellyson	1.0
14	Helo Advanced	Ellyson	1.0

* 1 January 1970.

2.27 Output. The outputs of the Base Loading Submodel include:

- Detailed listing by base of average student load, officers, enlisted men, civilians, total personnel for each training phase, tenants, and NAS personnel
- Listing of total aircraft assigned to each base
- Listing of annual fuel consumption by type for each base
- Listing of airspace saturation factors, OLF requirements, and runway requirements for each training aircraft assigned to the base.

Each of the above outputs is printed for the decision maker. In addition, the personnel, aircraft, and fuel data are entered into the Facilities Requirements Submodel, where they are used to determine the quantity of facilities required. The training phase and NAS personnel data are entered into the Total Systems Cost (TSC) Submodel for use in estimating pay and allowances. The training aircraft data are also entered into the TSC Submodel for use in estimating total aircraft requirements and deficiencies. Annual aircraft utilization is not printed in this model, but is entered into the TSC Submodel. Runway requirements are entered into the Excess/Deficiency Submodel, where runway deficiencies are calculated.

2.28 Illustrative Example. Sample computer inputs required from the decision maker and computer outputs provided to him for the previously discussed 2,510 PTR case are illustrated in the following paragraphs. Initially, the decision maker types his phase to base assignment schedule on the time-sharing terminal, as illustrated in Table 2.12, for the present NATRACOM assignment. The instructions for entering these data are printed by the computer and are shown at the top of Table 2.12. The phase number, the first four letters of the name of each base, and the fraction of phase assigned to that base are typed into the terminal. The realism of the phase to base assignment is a function of the judgment and creativity of the decision maker and not of the computer.

2.29 After the foregoing data are entered, the computer prints the output for each NAS utilized, as shown in Table 2.13 for NAS Meridian. To obtain these sample results, two training phases were assigned to NAS Meridian; the personnel data calculated by the LSR Generator for these phases are shown by phase. The sum of all phase personnel was then calculated in the Base Loading Submodel and appears as "All Phases" in the table. The tenant personnel were stored in the Base Data File for Meridian and printed as shown. The number of NAS personnel required to support the 2,111 training phase and tenant personnel (i.e., 2096 + 15) was calculated by the model and equals 1,065. The model also calculated the total personnel for the base to be 3,176 (i.e., 2,111 + 1,065).

TABLE 2.12

PHASE TO BASE ASSIGNMENT INPUT *

```
PHASE ALLØCATIØN:  ASSIGN EACH PHASE AS--
II,AAAA,.XX
WHERE: II = PHASE (2 DIGITS); AAAA = BASE CØDE;
      .XX = PERCENT AT BASE (1.0 = 100%)
BASE CØDES: CHAS CØRP ELLY
            KING MERI PENS
            SAUF WHIT PHAN**
II = 0 TØ TERMINATE:?01,SAUF,1.
NEXT?02,PENS,1.
NEXT?03,PENS,1.
NEXT?04,MERI,1.
NEXT?05,MERI,1.
NEXT?06,PENS,1.
NEXT?07,KING,1.
NEXT?08,CHAS,1.
NEXT?09,WHIT,1.
NEXT?10,SAUF,1.
NEXT?11,CØRP,1.
NEXT?12,PENS,1.
NEXT?13,ELLY,1.
NEXT?14,ELLY,1.
NEXT?0
```

* Underline indicates a user input.

** Completely new or "phantom" base.

TABLE 2.13

SAMPLE DETAIL PRINTOUT FROM BASE LOADING SUBMODEL (NAS MERIDIAN)

- BASE LOADING

NAS--MERI

PERSØNNEL	STD.LØAD	ØFFICERS	ENLISTED	CIVILIAN	TØTAL
BASIC JET-A	237.	159.	585.		981.
BASIC JET-B	186.	133.	795.		1115.
ALL PHASES	423.	292.	1380.		2096.
TENANTS		6.	9.	0.	15.
NAS PERS.		72.	606.	387.	1065.
TØTAL BASE		370.	1996.	387.	3176.

AIRCRAFT DATA

TYPE	NØ.
T-2A	97.
T2BC	101.
VT	2.
H	2.

FUEL DATA

TYPE	GALLØNS
JET	0.452E+08
AGAS	0.397E+06
HELØ	0.

- AIRSPACE FACTORS AND OLFs REQUIRED

NAS--MERI

TYPE A/C	AIRSPACE FACTØR	ØLF'S REQUIRED
T-2A	0.82	0.37
T2BC	0.64	0.29

- RUNWAY REQUIREMENTS BY BASE

REQUIRED:

AMØUNT	LENGTH	THICKNESS
0.82	5000.	1
0.64	5000.	1

2.30 The model next summed the aircraft requirements developed in the LSR Generator for all phases assigned to NAS Meridian. In this case, 97 T-2A aircraft were required for the Basic Jet A phase and 101 T-2B/C, by the Basic Jet B phase. The tenant and NAS aircraft located at this base were stored in the Base Data File by type of aircraft. In this case there were two trainer type aircraft and two helicopters assigned.

2.31 The fuel data are the sum of that required annually by each training phase, as developed by the LSR Generator, plus an amount consumed by the tenant and NAS aircraft, which is calculated in this submodel. The airspace saturation factors, OLFs required, and runways required are simply those calculated for the two Basic Jet phases by the LSR Generator.

2.32 A summary printout of the pertinent base loading data for all bases in the pilot training program is also available to the decision maker and is shown in Table 2.14. The average student load, total training phase personnel including students, total NAS personnel, total officers on base, total enlisted men on base, total civilians on base, and the total personnel on base are shown. Note that the NAS Meridian personnel data are the same as shown in Table 2.13. The aircraft required by type and number as well as fuel consumed by type and amount are for the training aircraft.

Facilities Requirements Submodel

2.33 The purpose of this submodel is to calculate the quantity of specific permanent facilities required to support CNATRA's pilot training program. Currently, 24 different facilities are included in the model. These facilities encompass approximately 50 different category codes and represent approximately 70 percent of the replacement value of the eight NASs.

2.34 Input. All the inputs to this submodel are either calculated by a preceding submodel or contained within the IFRS model. The base specific personnel, aircraft, and fuel requirements calculated by the Base Loading Submodel are entered directly into this submodel. The civil engineering planning factors associated with each aircraft type, e.g., the number of square yards of parking apron space occupied by an aircraft or the amount of warehouse space required by an aircraft type, are entered from the Aircraft Data File. Information concerning such base specific planning factors as family housing requirements factors and the depth of the aircraft parking apron is stored in the Base Data File and entered into this submodel when required. The user makes no data inputs to this submodel.

2.35 General Methodology. The model calculates the amount of each facility required at each base by using a series of mathematical expressions or equations incorporating a large number of civil engineering planning factors in conjunction with the inputs discussed above. In general, these equations were developed from standard Navy documents. However, planning factors for such facilities as roads, electrical distribution lines, and water distribution lines were not available. Thus, explicit equations were developed to estimate these requirements on the basis of an analysis of existing quantities of these facilities

TABLE 2.14

SAMPLE SUMMARY PRINTOUT FROM BASE LOADING SUBMODEL

BASE LØADING SUMMARY

*PERSONNEL								*AIRCRAFT		*FUEL	
	STD.	--------------BASE	TØTALS	------------						MILLIØN	GAL.
NAS	LØAD	PHASE [1/]	NAS [2/]	ØFF [3/]	ENL [3/]	CIV [3/]	TØTAL [4/]	TYPE	NØ.	TYPE	AMØUNT [5/]
CHAS	197.	1672.	951.	267.	1829.	330.	2623.	TA4J	153.	JP-4	46.79
CØRP	325.	2180.	2565.	602.	3639.	5900.	10466.	TS2A	164.	A115	12.45
ELLY	143.	705.	701.	152.	923.	188.	1406.	TH57	21.	AGAS	0.18
								THIL	54.	JP-4	3.39
KING	197.	1789.	982.	271.	1954.	349.	2771.	TF9J	170.	JP-4	58.89
MERI	423.	2096.	1065.	370.	1996.	387.	3176.	T-2A	97.	JP-4	45.20
								T2BC	101.		
PENS	783.	1501.	2902.	786.	2822.	7716.	12106.	T2BC	58.	JP-4	11.28
								T28C	18.	AGAS	0.71
SAUF	522.	1383.	877.	307.	1155.	277.	2260.	T34B	129.	AGAS	2.42
								T28C	36.		
WHIT	658.	2328.	1133.	401.	2004.	442.	3504.	T28C	283.	AGAS	10.10

1/ Total training phase personnel located at the base including average student load (i.e., the same as "All Phases" in Table 2.13).

2/ Total NAS personnel required to support the training phase and tenant personnel.

3/ Includes phase, NAS, and tenant personnel.

4/ Sum of student load, officers, enlisted men, and civilians.

5/ Millions of gallons.

located at each base. This approach assumes that the existing quantity of these facilities is adequate for a base of the given size. Once the requirements for all facility types [3/] are calculated for one base, the same procedure is repeated for each other base in the pilot training program. A detailed discussion of the methodology used in this submodel is included in Appendix D of Volume II.

2.36 Output. The output of this submodel provides the decision maker with a list of facilities, the amount of each required, and the unit of measure for each NAS. These are essentially the data currently calculated manually by each base for its Basic Facilities Requirements List. These same facility requirements are also entered into the Excess/Deficienty Submodel.

2.37 Illustrative Example. A list of the facilities included and the amount of facilities required for NAS Meridian[4/] with the 2,510 PTR previously discussed appear in Table 2.15. The category code of each facility appears in the first column, the second identifies the facility, the amount of that facility required is next, and finally, the unit of measure is shown. The unit of measure used for each facility line item is consistent throughout each of the submodels. The component parts of parking aprons, Category Code 11320, and total warehouse, Category Code 44210, are shown separately, since these subcategories are of interest to the decision maker. For example, the model shows that 350,000 sq yd of parking aprons are required. This amount is made up of 221,667 sq yd of actual parking apron plus 128,333 sq yd of peripheral taxiway.

2.38 For this hypothetical pilot training program, NAS Meridian requires no additional runways, and thus no requirements are calculated for taxiways and runway lighting.

Excess/Deficiency Submodel

2.39 The purpose of the Excess/Deficiency Submodel is to compare the facility requirements associated with a specified PTR, MIX, and MODE with the facilities available at each base and then compute net requirements (excess or deficiencies) for each facility line item.

2.40 Input. Two major inputs are required by this submodel: the facility requirements (calculated in the previous submodel) and a listing of the total permanent facility assets located at each base (stored in the Assets Position Data File). This data file includes a listing by line item of the total amount of facilities currently in existence at each of the eight pilot training NASs. A distinction

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[3/] Due to the unique runway configuration at each base, the model assumes that all existing runways have adequate taxiways and lighting. Thus, a requirement for these two facilities is calculated only when a new runway is built or an old runway is extended.

[4/] In the operation of the IFRS, this printout appears with the printout of the Excess/Deficiency Submodel, as shown in Table 2.16.

TABLE 2.15

LIST OF FACILITIES INCLUDED IN IFRS MODEL AND FACILITY REQUIREMENTS FOR NAS MERIDIAN*

IFRS Category Code	Facility Description	Required Amount	Unit
1320	Aircraft Parking Apron	221,667	sq yd
1320	Peripheral Taxiways	128,333	sq yd
11320	Total Parking Apron	350,000	sq yd
12540	Distribution Pipeline	3	miles
14140	Aircraft Operations Building	16,956	sq ft
17110	Academic Building	5,758	sq ft
21110	Aircraft Maintenance Hangar	222,732	sq ft
21910	Public Working Maintenance Shop	9,364	sq ft
4210	General Warehouse	125,000	sq ft
4210	Shed Space	8,074	sq ft
44210	Total General Warehouse	133,074	sq ft
55010	Dispensary With and Without Beds	17,037	sq ft
61010	Administrative Office	51,447	sq ft
71110	Family Housing (Officer and Eligible Enlisted Men) (EM)	1,319	units
	Family Housing (Ineligible EM)	208	units
72210	EM Barracks With/Without Mess	937	men
72310	EM Mess Hall	11,941	sq ft
72415	BOQs With/Without Mess	325	men
74014	Exchange	13,050	sq ft
74063	EMs Service Club	12,685	sq ft
81230	Distribution Line (Electrical)	115,876	ft
84210	Water Distribution Line (Potable)	53,463	ft
85110	Roads	20	miles
85210	Parking Areas	83,729	sq yd
	Runway Lighting		ft
	Taxiways		sq yd

Ready Fuel Storage Required (thousands of gallons):

Jet	1374.7
Avgas	12.1

* Runway requirements are specified in Base Loading Submodel.

TABLE 2.16

SAMPLE PRINTOUT OF FACILITIES REQUIREMENTS SUBMODEL, ASSETS POSITION DATA FILE, AND EXCESS/DEFICIENCY SUBMODEL FOR NAS MERIDIAN
(Use Standard Facilities Only for Excess/Deficiency)

CODE	DESCRIPTIØN	REQUIRED AMØUNT	UNIT	AVAILABLE STAND.	AVAILABLE SUB-STAND.	PØSITIØN EXCESS	PØSITIØN DEFICIENT
1320	A/C PKNG APN	221667.	SY				
1320	PER TAXIWAY	128333.	SY				
11320	TØT PKNG APN	350000.	SY	288263.	0.	0.	61737.
12540	DIST PIPELIN	3.	MI	2.	0.	0.	1.
14140	A/C ØP BLDG	16956.	SF	12217.	0.	0.	4739.
17110	ACADEMC BLDG	5758.	SF	30023.	0.	24265.	0.
21110	MAINT HANGAR	222732.	SF	125764.	0.	0.	96968.
21910	PW MAINT SHP	9364.	SF	9080.	0.	0.	284.
4210	GEN WAREHØUS	125000.	SF				
4210	SHED SPACE	8074.	SF				
44210	TØT WAREHSE	133074.	SF	95893.	14880.	0.	37181.
55010	DISPENSARY	17037.	SF	19562.	0.	2525.	0.
61010	ADMIN ØFFICE	51447.	SF	33938.	0.	0.	17509.
71110	FAM HØUSING	1319.	UN	760.	131.	0.	559.
0	INELIG HØUSE	208.	UN	121.	15.	0.	87.
72210	EM BARRACKS	937.	MN	1148.	0.	211.	0.
72310	EM MESS HALL	11941.	SF	19241.	0.	7300.	0.
72415	BØQ	325.	MN	275.	0.	0.	50.
74014	EXCHANGE	13050.	SF	18610.	0.	5560.	0.
74063	SERVICE CLUB	12685.	SF	7507.	0.	0.	5178.
81230	ELEC DIST LN	115876.	LF	111340.	0.	0.	4536.
84210	WATER DIS LN	53463.	LF	72089.	0.	18626.	0.
85110	RØADS	20.	MI	14.	0.	0.	5.
85210	PARKING AREA	83729.	SY	76290.	0.	0.	7439.

TAXIWAYS & RUNWAY LIGHTING
NØ DEFICIENCY
READY FUEL STØRAGE
REQUIRED: (THØUSANDS ØF GALS)
JET 1374.7
AVGAS 12.1
AVAILABLE:
JET 2335.0
AVGAS 50.0
HELØ 0.
NØ DEFICIENCY

RUNWAYS

AVAILABLE:

AMØUNT	LENGTH	THICKNESS
0.90	8000.	9
0.90	8000.	9
0.74	6400.	9

REQUIRED:

AMØUNT	LENGTH	THICKNESS
0.82	5000.	1
0.64	5000.	1

NØ RUNWAY DEFICITS

is made between those facilities classified as standard and those classified as inadequate. The decision maker has the option to use existing standard facilities or total facilities (i.e., standard as well as substandard) for computing the excesses or deficiencies. He enters his choice simply by typing in a Y for "Yes" or N for "No" when queried by the computer.

2.41 General Methodology. In general, the excesses or deficiencies are calculated on the basis of a comparison of amount of facility required to the amount in existence. If the amount of facility required exceeds the amount currently in existence, the arithmetic difference between the two amounts is calculated as a deficiency for that facility line item. Conversely, if the amount of facility required is less than that currently in existence, the difference is an excess. This same process is repeated for each facility type, with the exception of runways, taxiways, and runway lighting. The peculiar characteristics of runways necessitate a comparison of amount, length, and thickness of required runways and existing runways. The model assumes that all taxiways and runway lighting currently in existence are adequate and that no deficiencies currently exist. Deficiencies are calculated for these two items when an existing runway must be extended or a new runway built. The foregoing procedure is then repeated for each base in the pilot training program. A detailed discussion of the Excess/Deficiency Submodel appears in Appendix G. The runway portion of the calculation is described in Appendix H.

2.42 Output. The output of this submodel for each base in the pilot training program being evaluated is a list of the amount of excess or deficiency by facility line item. When a deficiency exists in ready fuel storage tanks, the output lists the number and size of tanks required to make up the deficiency. For runways, the submodel prints no deficiency, upgrade specific existing runway to new length and/or thickness, or build new runways to specific length and thickness. These outputs are printed for each base. In addition, all facility deficiencies are entered into the TSC Submodel for use in estimating the cost to eliminate all deficiencies.

2.43 Illustrative Example. For the 2,510 PTR pilot training program used throughout this report, assume the decision maker wants to determine the facility excesses or deficiencies with respect to using standard facilities only. Since the IFRS model is designed to print in one matrix the outputs of the Facilities Requirements Submodel and the Excess/Deficiency Submodel along with the data stored in the Assets Position Data File, the decision maker receives the data shown in Table 2.16. The facilities requirements information shown in the table was discussed in the foregoing subsection. The amount of available standard and substandard facilities at NAS Meridian is the information stored in the computer. The excesses or deficiencies are computed by arithmetic comparison. For instance, there are 288,263 sq yd of parking apron available at NAS Meridian and classified as standard. The requirement of 350,000 sq yd exceeds the existing inventory; the deficiency equals the difference, or 61,737 sq yd. The same process is repeated for the other facilities noted.

2.44 The model states that there are neither runway nor ready fuel storage deficiencies for NAS Meridian. Consequently, a hypothetical base was used to illustrate the model output received when these facilities are deficient and is shown in Table 2.17. The number and size of ready fuel storage tanks required to overcome the deficiency are shown. According to the printout data for runways, one existing runway must be extended. Due to the unique modeling of runways, the cost of extending the runway is also printed at this point. The amount of available runways equals the amount of time the runway is available as a primary runway, corrected for wind rose data.

Total Systems Cost Submodel

2.45 The purpose of the IFRS Total Systems Cost (TSC) Submodel is to calculate the total systems cost of each pilot training alternative. Since the common unit of measure for all resources is dollars, the total cost of alternative training programs is extremely important to the decision maker. The submodel includes the following elements of investment and operations and maintenance (O&M) costs:

- Investment costs
  - Facility
  - Aircraft
- Operations and maintenance (O&M) costs
  - Military pay and allowances
  - Aircraft fuel
  - Aircraft support
  - Base support
  - Fixed costs.

2.46 Input. The TSC Submodel is the final submodel of the IFRS and thus receives inputs from many of the preceding submodels. The inputs received from the Base Loading Submodel include the number of enlisted men and officers assigned to the training phases and NAS, the number of training aircraft required by type, and the annual aircraft utilization by type. Inputs received from the Facilities Requirements Submodel include the amount of facility required by line item. The amount of deficient facilities is entered from the Excess/Deficiency Submodel. Aircraft cost factors are contained in the Aircraft Data File. The decision maker must enter the amount and type of facilities he does not want to "build" in the current year for each base. He must also enter the responses required either to terminate the computer run or return to the LSR Generator to run the model for another year.

TABLE 2.17

SAMPLE PRINTOUTS FOR RUNWAY AND READY FUEL STORAGE DEFICIENCIES

```
AVAILABLE:
AMØUNT LENGTH THICKNESS
 0.84   8000.      9
 0.84   5000.      2
 0.82   5000.      2
 0.62   5000.      2
 0.64   5000.      2
REQUIRED:
AMØUNT LENGTH THICKNESS
 1.36   8000.      2
UPGRADE: LENGTH: 5000. TØ  8000.
THICKNESS:        2 TØ       2
CØST:     424. (THØUS.)
SUMMARY ØF RUNWAY UPGRADE/CØNSTRUCTIØN
NØ. LENGTH THICKNESS CØST (THØUS.)
 1  8000.      2       424.
 WILL THESE DEFICITS BE MADE UP (Y,N)?Y


READY FUEL STØRAGE
 REQUIRED:   (THØUSANDS ØF GALS)
  JET            103.1
  AVGAS           16.5
 AVAILABLE:
  JET              0.
  AVGAS          115.0
  HELØ             0.
 DEFICIENT
 NØ.     SIZE* TYPE
  2.        1. JET
  1.        2. JET
  2.       50. JET
```

*Thousands of gallons.

2.47 General Methodology. For each facility line item in which a deficiency exists, the submodel multiplies the amount of that deficiency by the appropriate facility cost estimating relationship (CER) stored in the computer.[5] The facility costs calculated are for those facilities included in the IFRS model.[6] The submodel assumes that facility deficiencies are corrected to the extent necessary unless the decision maker specifies otherwise. The above process is repeated for each base in the pilot training program.

2.48 Aircraft investment costs are estimated by first comparing total aircraft requirements[7] to the existing CNATRA training aircraft inventory for each aircraft type. When the aircraft requirements exceed the current inventory, the model calculates the cost of procuring these incremental aircraft on the basis of flyaway cost factors stored in the computer. An estimate of the initial support (e.g., spares and spare parts) required by a new aircraft is calculated as a function of the flyaway cost. This process is then repeated for each aircraft type used in the pilot training program.

2.49 O&M costs are estimated by summing the cost components for each base. The military pay and allowances cost is estimated by multiplying the number of training phase and NAS personnel by standard Navy pay and allowance factors stored in the model. The annual fuel cost is estimated by multiplying total fuel consumption by unit cost for each type of fuel. Aircraft support cost is a function of aircraft annual utilization and cost per flight hour planning factors. The base support costs are an estimate of the amount of money required to maintain and operate the NAS. These costs are estimated from an equation that was developed from FY 69 operations and maintenance data.[8] The costs associated with two of the items that make up base support costs (civilian wages and facility O&M) are of special interest to the decision maker. When the civilian wages and facility O&M costs were deducted from the base support costs, a reasonable estimate of the remaining base support costs could not be generated. Consequently, the base support costs are estimated as stated above and civilian wages and facility O&M costs are estimated as non-add items, since they are already included in the estimate of base support costs. Civilian wages are estimated by multiplying the number of NAS civilians by an average wage rate. Facility O&M costs are calculated by facility line item for the total facilities currently in existence plus those "built" by the model, they are based on standard Navy planning factors. The total annual cost associated

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5/ The CERs are included for all facilities except the ineligible family housing, which the Government does not build.

6/ A rough estimate of the total cost required to "build" all deficiencies can be obtained by dividing the total facility investment cost by .66 since the facilities included in the model account for 66 percent of the total base replacement values.

7/ The number of operational aircraft calculated in LSR Generator is increased by 15 percent to account for those in the overhaul cycle.

8/ These are essentially the O&M funds provided to each NAS.

with the CNATRA, Chief of Naval Air Basic Training (CNABATRA), and Chief of Naval Air Advanced Training (CNAVANTRA) staffs is added into the O&M costs as a fixed dollar amount.[9]

2.50 All costs are estimated in current dollars, and the model has the capability to include an inflation index to allow for cost escalation over time. A detailed discussion of the TSC methodology is included in Appendix I.

2.51 Output. The output of the TSC Submodel is a dollar estimate of the cost of "building" facilities, procuring aircraft, and maintaining and operating the training phases and NAS. These cost estimates are printed for use by the decision maker. If the IFRS model is to be run for a second year, the amount of facility "built" by line item is temporarily added to the Assets Position Data File to ensure that the same facility is not calculated as having been built again the next year.

2.52 Illustrative Example. A detailed listing of the facility investment cost required to eliminate all facility deficiencies appears in Table 2.18 for NAS Meridian. The decision maker can readily determine that it will cost approximately $694,000 to build the 61,737 sq yd of parking apron required to eliminate the deficiency. The computer model assumes that all facilities listed in Table 2.18 are "built" in this year unless the user enters specific instructions to the contrary. The bottom part of Table 2.18 shows the computer printout of the estimated aircraft flyaway, support, and total procurement cost, including a listing of number required and current inventory for each aircraft used in the training program.[10]

2.53 A detailed printout for the O&M costs of each base appears in Table 2.19. The facility O&M costs provide the decision maker with an estimate of the average cost of maintaining the facilities included in the IFRS model.[11] As discussed above, the facility O&M costs plus the civilian wages (i.e., $286,800 plus $2,710,000, or $2,996,800) are already included in the base support total of $4,256,200 and thus are non-add items. The military pay and allowances costs are shown for officers and enlisted men for training phase and NAS and also for students. The annual costs for aircraft fuel and O&M are provided as shown. The total base support cost for all eight bases is within approximately 10 percent of the actual FY 69 expenditures. A summary listing of these O&M costs is also available to the decision maker as shown in the sample printout in Table 2.20. All major annual expenditures are included in the IFRS; thus, the O&M costs represent approximately 100 percent of the actual annual cost of running the pilot training program.

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[9] Currently $6.2 million.

[10] The current inventory is the number of aircraft available to CNATRA as of January 1969.

[11] Family housing O&M funds are not presently included.

TABLE 2.18

SAMPLE PRINTOUT OF FACILITY INVESTMENT COST FOR NAS MERIDIAN

```
NAS--MERI
 FACILITIES  COSTS ($000)
DETAILED BREAKDØWN (Y,N)?Y
11320 TØT PKNG APN      693.8
12540 DIST PIPELIN       65.7
14140 A/C ØP BLDG       244.0
21110 MAINT HANGAR     2467.0
21910 PW MAINT SHP       10.3
44210 TØT WAREHSE       383.9
61010 ADMIN ØFFICE      493.2
71110 FAM HØUSING     11414.7
72415 BØQ               560.6
74063 SERVICE CLUB      176.0
81230 ELEC DIST LN       26.2
85110 RØADS             393.0
85210 PARKING AREA       32.1

          BASE TØTAL  16960.6
```

SAMPLE PRINTOUT OF AIRCRAFT INVESTMENT COSTS, $000

A/C INVESTMENT & ASSET PØSITIØN---CNATRA

	ASSET PØSITIØN			------ CØSTS (THØUS.) ----		
A/C	AVAILABLE	REQ'D	DEFICIT	FLYAWAY	SUPPØRT	TØTAL
T34B	150.	149.	0.	0.	0.	0.
T28C	469.	388.	0.	0.	0.	0.
T-2A	114.	112.	0.	0.	0.	0.
T2BC	178.	183.	5.	2740.	411.	3151.
TF9J	399.	196.	0.	0.	0.	0.
TA4J	100.	176.	76.	83809.	12571.	96381.
TS2A	179.	188.	9.	18103.	2715.	20818.
THIL	0.	62.	62.	24732.	3710.	28441.
TH57	34.	25.	0.	0.	0.	0.

TABLE 2.19

SAMPLE DETAIL OPERATIONS AND MAINTENANCE PRINTOUT FOR NAS MERIDIAN ($000)

NAS--MERI		
11320	TØT PKNG APN	9.8
12540	DIST PIPELIN	1.7
14140	A/C ØP BLDG	4.5
17110	ACADEMC BLDG	8.0
21110	MAINT HANGAR	59.5
21910	PW MAINT SHP	2.5
44210	TØT WAREHSE	11.2
55010	DISPENSARY	7.2
61010	ADMIN ØFFICE	15.9
72210	EM BARRACKS	42.4
72310	EM MESS HALL	5.7
72415	BØQ	48.1
74014	EXCHANGE	4.2
74063	SERVICE CLUB	2.9
81230	ELEC DIST LN	13.0
84210	WATER DIS LN	8.1
85110	RØADS	27.2
85210	PARKING AREA	4.7
11110	RUNWAYS	10.0
*	SUBTØTAL	286.8
*	CIVILIAN WAGES	2710.0
PAY & ALLØWANCES		
	PHASE ØFFICERS	4700.2
	PHASE ENLISTED	8074.3
	STUDENTS	3559.5
	NAS ØFFICERS	999.3
	NAS ENLISTED	3545.0
	SUBTØTAL	20878.3
A/C FUEL		5808.5
A/C Ø & M		1972.8
BASE SUPPØRT		4256.2
	TØTAL	32915.8

TABLE 2.20

SAMPLE PRINTOUT OF SUMMARY O&M COSTS ($000)

SUMMARY Ø & M CØSTS

NAS	MILITARY P&A	A/C FUEL TØTAL	A/C Ø&M TØTAL	BASE SUPPØRT	TØTAL
CHAS	16459.5	6009.5	3750.9	3630.3	29850.1
CØRP	28110.4	2625.3	1919.5	12514.4	45169.7
ELLY	8921.8	522.9	372.6	2251.1	12068.4
KING	17258.3	7547.1	2651.8	3797.5	31254.8
MERI	20878.3	5808.5	1972.8	4256.2	32915.8
PENS	29650.4	2482.7	591.6	14372.0	47096.7
SAUF	15866.8	472.1	394.0	3219.1	19952.0
WHIT	23284.6	1747.0	1155.6	4628.3	30815.5

TØTAL Ø & M CØST
ALL BASES 249122.9

2.54 A summary of the cost information provided by this submodel appears in Table 2.21. To train the 2,510 pilots in the sample pilot training program discussed in this report, the TSC is approximately $540,000,000. Annual O&M costs account for 47 percent, facility investment for 25 percent, and aircraft investment accounts for 28 percent of this expenditure.

FLEXIBILITY OF THE IFRS MODEL

2.55 The automation of the IFRS model was completed with emphasis on providing CNATRA with a flexible planning tool that would calculate answers to a multitude of management questions concerning current as well as future pilot training programs. This flexibility was built into the IFRS model by writing the computer programs in a conversational mode. The result is a model which asks the decision maker various questions to which he must reply before the model proceeds with its calculations. Thus, for example, the decision maker may choose among alternative levels of printing detail; may easily change the data files when required by changes in the training pipeline, training aircraft, syllabi, etc.; may allocate training phases to different bases; and may determine maximum PTR, for given training resources (i.e., work backwards through the model).

Backwards Operation of the IFRS Model

2.56 An extremely useful feature of the IFRS model is the built-in capability to run the model backwards. The decision maker can then determine how a limited supply of aircraft, flight instructors, and/or enlisted men in one phase of training affects student output for successive and preceding training phases, and the resulting base loading, facility requirements, facility excesses or deficiencies, and total systems cost.

2.57 This option is extremely simple for the decision maker to use, as shown by the following example. For the 2,510 PTR, the LSR Generator calculates that 36 aircraft, 22 flight instructors, and 238 enlisted men are required to train the 1,460 students in the Basic Prop CQ training phases, Phase 10. Assume that NATRACOM has only 28 aircraft, 19 flight instructors, and 200 enlisted men available for this phase of training. Consequently, the 1,460-student output cannot be achieved using these limited resources, assuming that the syllabus and all other factors remain constant. The student output that can be achieved for this phase of training with each of the three limited resources (i.e., aircraft, flight instructors, and enlisted men) is quickly calculated by the IFRS model after the decision maker enters a few inputs through the time-sharing terminal. With 28 aircraft, 1,130 students can be trained in the Basic Prop CQ phase. The available flight instructors can train 1,270 students and the enlisted men can support a student output of 1,229. The above unconstrained (i.e., desired) student output with the required resources and the constrained student outputs that can be achieved with the available resources appear in Table 2.22.

TABLE 2.21

SAMPLE TOTAL SYSTEMS COST FOR
2,510 PTR AT EIGHT NASs
($ Million)

Category	Cost
Investment	
Facility	$136
Aircraft	149
Operations and Maintenance	249
Fixed Costs	6
Total	$540

TABLE 2.22

CONSTRAINED RESOURCES EXAMPLE
(Basic Prop CQ Phase)

Resource	Required Resources	Unconstrained Student Output	Available Resources	Constrained Student Output
Aircraft	36	1,460	28	1,130
Flight instructor	22	1,460	19	1,270
Enlisted men	238	1,460	200	1,229

2.58 Observed that, of the three limited resources, the aircraft inventory is the overriding constraint since with it, the student output is lowest. The IFRS model identifies this overriding constraint and prints out a new detailed listing of personnel, aircraft, and fuel requirements on the basis of the availability of 28 aircraft. For purposes of comparison, the LSR Generator output of the unconstrained and constrained Basic Prop CQ phase appears in Table 2.23. Even though 19 flight instructors are available, only 17 are required. Furthermore, 16 fewer enlisted support men are required than are available. The process of calculating this constrained student output takes only a few minutes. Once it is calculated, the decision maker must decide which student source (i.e.,Navy Officer, Navy AOC, or Marine) and how many of each are to be trained in this phase. A hypothetical decision of how the 1,130 students might be divided appears in Table 2.24, along with the unconstrained student outputs identified above in the discussion of the LSR Generator. Once the decision maker types these three new constrained student outputs into the time sharing terminal, the effect of having only 28 aircraft for the Basic Prop CQ phase is propagated throughout all training phases because of the sequential nature of the submodels. The new printouts from the LSR Generator reflect this constraint. In the foregoing example, no changes were made in the jet side of the pipeline, since the jet students do not pass through the constrained phase. Similarly, the student statistics for Coast Guard and foreign students remained constant, since these students do not pass through the Basic Prop CQ phase. Any of the training phases can be constrained in a similar manner at the discretion of the decision maker.

Printing Options of the IFRS Model

2.59 The decision maker selects the level of detail for the model printout to obtain the data he requires for his analysis of the pilot training program. All that is necessary is to type in a Y for "Yes," N for "No," or a number from 1 to 5. Some of the printing options available are:

- Print pipelines
- Print total list of training phases in model with planning factors associated with each
- Print either detailed training phase or summary training phase data of LSR Generator
- Print Airspace Saturation Factors and OLFs required by base
- Print runway requirements, excesses, and deficiencies by base
- Print either detailed base loading data for all bases or summary data from the Base Loading Submodel

TABLE 2.23

COMPARISON OF CONSTRAINED AND UNCONSTRAINED
LSR GENERATOR OUTPUT
(Basic Prop CQ Phase)

Type of Output	Constrained	Unconstrained
Student Input	1,135	1,467
Student Output	1,130	1,460
Average Student Load	91	117
Administrative Officers	9	12
Total Officers	35	45
Total Enlisted	184	238
Aircraft Types	T-28C	T-28C
Number Required	28	36
Fuel Types	AGAS	AGAS
Gallons Consumed	.856M	1.11M
Flight Instructors	16	20
Under Training	1	2
LSO Requirements	9	12
Enlisted Support	184	238

TABLE 2.24

BASIC PROP CQ STUDENT
OUTPUT BY TYPE

Student Source	Unconstrained	Constrained
Navy Officer	514	410
Navy AOC	658	520
Marines	287	200
Total	1,460	1,130

- Print detailed facility requirements, excesses, and deficiencies or print list of deficient facilities only

- Print detailed or summary facility investment cost

- Print detailed or summary aircraft investment cost

- Print either detail or summary O&M costs

- Print TSC and skip all printing between Base Loading and TSC Submodels

- Print listing of Aircraft and Base Data Files.

Other Operating Options of the IFRS Model

2.60 In addition to the above, the options described in the following paragraphs provide the decision maker with greater flexibility in using the IFRS model.

2.61 The model is designed to store temporarily the data calculated by the LSR Generator. This storage procedure permits the user to continue directly into the Base Loading Submodel. Further, the user can stop the analysis at this point and restart the Base Loading Submodel at a later time without recalculating the LSR generated data. Additionally, this feature permits the user to evaluate several phase to base assignments for one PTR without going back through the LSR Generator.

2.62 The user is offered the following options at this point:

- If the airspace at a base is oversaturated, the decision maker can return to the Base Loading Submodel to reassign the training phases to different bases.

- The decision maker can use existing standard or combined standard and substandard facilities in calculating facility excesses and deficiencies. He can change this option and recycle through the Excess/Deficiency Submodel prior to entering the TSC Submodel.

- The decision maker can specify by line item the amount of deficient facilities to be "built."

- The IFRS model can be run for several years in the future to determine how requirements vary by year. If the decision maker recycles the IFRS for a second year, facilities that were built in the first year are temporarily added to the Assets Position Data File to ensure that the same facility is not shown as having been "built" twice.

Flexibility in Changing Data Files

2.63 The flexibility in changing data files results from the modular design of the total IFRS model. The data files are readily accessible and easy to update. A data change affects a small segment of a program; thus, no new programming is necessary when, for example, new planning factors are needed.

2.64 The IFRS model can currently accommodate 25 training phases to provide the decision maker with a capacity to construct and test a multitude of training alternatives. New training phases can be added and old phases deleted or changed by typing in the proper response to questions asked by the model.

2.65 A new training phase can be added by typing in the 17 items of data that define a phase (shown in Table 2.1), as discussed in the LSR Generator subsection. A phase can be modified by typing in the line number of the data and the new value for that piece of data for each phase. For example, assume CNATRA is considering changing the current 14-phase pipeline to a hypothetical new 11-phase pipeline, as shown in Figure 2.3. The two major differences in the pipelines are that the new one combines the Basic Jet A and Basic Jet B phases into one new Basic Jet phase and Helo students go directly from the Flight Systems phase to the new Basic Helo phase (i.e., they no longer pass through the Basic Prop phases). Obviously, the Basic Helo phase would include the academic and flight instruction required for these students to successfully enter the Advanced Helo phase. These new training phases and the pipeline associated with each student source can be easily entered into the IFRS model. Then the decision maker can analyze alternative PTRs and phase to base assignments for this new training program.

2.66 The Assets Position, Aircraft, and Base Data Files can also be modified when desired. Instructions for such changes are contained in the User's Manual, Volume III of this report.

2.67 Several options are available to the user of the IFRS in its current state. The Performance Model described in Appendix J and the Sensitivity Analysis described in Appendix L provide good illustrations of how the decision maker can use this flexibility in analyzing alternative pilot training programs.

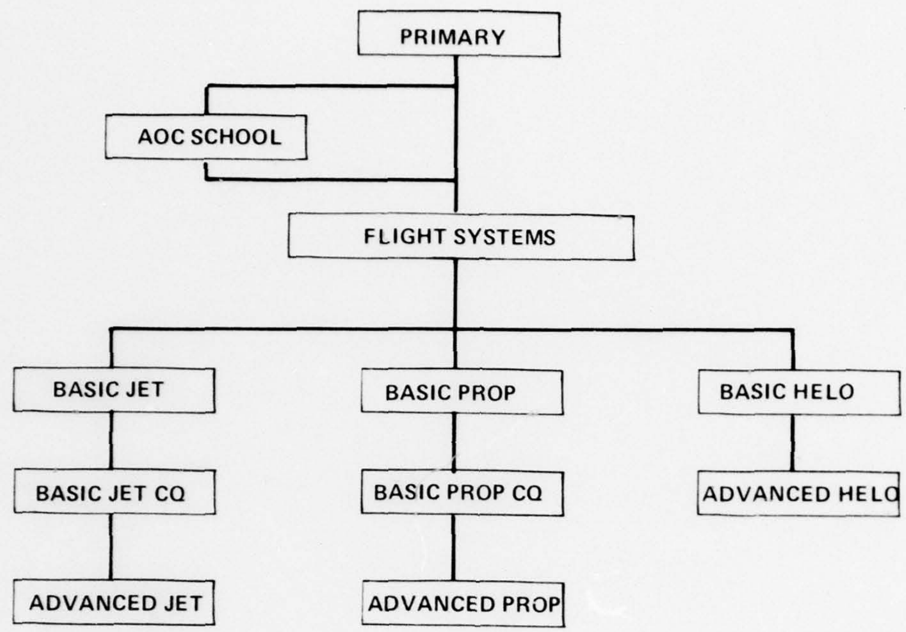

FIGURE 2.3. SAMPLE HYPOTHETICAL NEW PIPELINE

III. CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

3.1 The complete IFRS model was developed on a rough-cut basis in Phase II and is programmed and operational on a time-sharing computer system. The IFRS model rapidly provides accurate and relevant answers to questions concerning what happens if changes occur in certain parts of the pilot training program. Its output provides answers identical to the results that are currently produced manually as well as additional planning information that is extremely useful to the CNATRA staff members, especially those concerned with facilities management. The user of the model must understand what the model can and cannot do and remember that refinements will be made in Phase III of the study. The IFRS model does not make decisions for the CNATRA staff, but it does greatly facilitate the development of data to support CNATRA management planning.

Benefits of Phase II

3.2 The use of the IFRS planning model by CNATRA staff members will benefit the pilot training program by contributing to better management in the following ways

- Provides NATRACOM with an integrated management planning tool that generates timely, accurate, and relevant information for alternative training programs
- Provides a common basis for computing facility requirements, excesses, and deficiencies for pilot training programs, by forcing management to define every alternative in the same analytic framework

- Facilitates efficient utilization of excess facilities
- Provides information useful in the formulation of NATRACOM's Military Construction (MCON) plans on both an annual and extended time period basis
- Provides the financial information required to determine which training alternative minimizes total training cost
- Frees management from making extensive routine calculations, giving them more time to manage, analyze, and make decisions
- Permits more alternatives to be analyzed in greater depth
- Provides the capability to test and analyze consequences of alternatives before making decisions
- Minimizes the risk of making the wrong decision
- Provides quick answers to questions asked in daily operations of NATRACOM, budget hearings, and review meetings
- Enhances a smooth transition during the change in management resulting from military personnel transfers.

RECOMMENDATIONS

Phase II

3.3 ORI recommends that CNATRA install a time-sharing terminal to permit the CNATRA staff members responsible for managing the pilot training program to immediately begin reaping the benefits offered by the IFRS model. It is recommended that, as an initial step, the personnel in the Staff Civil Engineering Section and personnel in the Training/Plans Division use and become familiar with the model's capabilities and limitations. By using the model, these decision makers will be able to observe firsthand the model outputs that are identical to those currently generated by hand and the model outputs which provide facility planning information not previously available without extensive manual calculation. The cognizant managers will then be able to incorporate the IFRS model outputs into the management decision process of the total pilot training program.

3.4 Model Limitations. The model developed in the Phase II study is a preliminary total systems model. Even though the logic of the model is correct, its output is limited in certain ways. Regression analysis was used to develop linear estimating equations when other available alternatives were not conducive to time-sharing application.[1/] The resulting equations have a high degree of correlation. However, the precise quantity calculated for any one base may be somewhat higher or lower than the value actually required. This effect is particularly evident in the estimation of the base support O&M cost calculated in the TSC Submodel, where the sum of base support costs for all eight NASs is within approximately 10 percent of the actual value, but the estimated cost of individual bases is not consistently that close to the actual cost.

3.5 Regression equations were also developed for estimating the number of NAS personnel and the amounts of fuel distribution pipelines, water distribution lines, electrical distribution lines, roads, and parking areas required; these equations assume that the number of NAS personnel at a base and the amount of each of the above facilities currently in existence are adequate to support the total base load.

3.6 The planning factors available to the study and currently contained in the IFRS model, which are used to calculate runways, OLFs, and academic classroom requirements, appear to understate these requirements.

3.7 A lack of consistency was encountered in the data sources available for establishing the amount and condition of existing facilities appearing in the Assets Position Data File. Consequently, some of these facilities may be over- or understated or misclassified. Note that the model's limitations are minor and will be corrected as the quality of the data improves.

3.8 The intent of the Phase II IFRS study was to develop a total systems planning tool that works, provides useful answers, and can be used by the decision maker—the Phase II model does all of these. However, certain assumptions had to be made in order to develop the preliminary total model. For example, when regression analysis was used, linear relationships were assumed where necessary to facilitate model development. These model limitations will be studied further in Phase III in order to develop a more complete planning tool.

Recommended Scope for Phase III

3.9 In Phase III, the preliminary total IFRS model developed in Phase II will be refined and expanded so that the model can estimate between 85 and 90 percent of the actual total systems cost of the pilot training program. Additional facilities may be included on the basis of their high cost, mission importance, or unique base requirement. Additional printing options will be made available to the decision maker to increase the ease of model operation and usefulness of output.

1/ A discussion of the quantification problems encountered appears in Appendix K, Volume II.

The estimating equations developed from regression analysis will be analyzed to determine whether better estimators can be developed. Changes in Facility Planning Factors for Naval Shore Activities (NAVFAC P-80) and Category Codes for Classifying Real Property of the Navy (P-72) will be incorporated into the model. All of these refinements and expansions must be compatible with time-sharing computer operations.

3.10 In addition, an optimization search algorithm will be developed to minimize TSC for any given PTR, MIX, and MODE or to maximize performance for any level of cost. This submodel will also be programmed on the time-sharing computer system. Extensive use will be made of the Performance Model developed by the Navy as shown in Appendix J.

3.11 During Phase III, a separate submodel will also be developed that will simulate the pilot training program on a weekly basis (i.e., a dynamic model versus the static model of Phase II). This submodel will be used to identify peak and slack loading periods in the various phases of training.

3.11 Both of these additional submodels will be completely compatible with the existing IFRS model. They will be completed as separate submodels to ensure continuity in the flexibility of the present model.