

A DEVELOPMENT OF A FIRE SUPPORT  
SIMULATION LOGIC FLOW

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# NAVAL POSTGRADUATE SCHOOL

## Monterey, California



# THESIS

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SIMULATION LOGIC FLOW

by

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March 1973

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A Development of A Fire Support Simulation Logic Flow

by

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## ABSTRACT

This paper develops fire support logic for use in an educational war game simulating ground combat at the platoon/company level. Included within the logic are provisions for:

- 1) Given a requirement for supporting fires, selecting a weapon system: mortars; artillery; naval gunfire; or air.
- 2) Selection of an artillery unit to fire.
- 3) Generation of amount and time of ordnance delivery for mortars, artillery and naval gunfire.

Work was coordinated with the development of the Tactical Exercise Simulator and Evaluator (TESE) by the United States Marine Corps, and was integrated into the initial models for testing and refinement.





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## TABLE OF ABBREVIATIONS

A/C	Aircraft
AG	Aggressor
ARTY	Artillery
ATF	Amphibious Task Force
ATT	Artillery Target Type ( = 0 implies the target is to be attached by 8 inch or larger. = 1 implies the target may be attacked by 105 or 155 howitzers.)
AWS	Amphibious Warfare School
BLT	Battalion Landing Team
Bn	Battalion
Btry	Battery
CATF	Commander Amphibious Task Force
CLF	Commander Landing Force
Co	Company
CPX	Command Post Exercise
DASC	Direct Air Support Center
D/S (DS)	Direct Support
FAC	Forward Air Controller
FAC (A)	Forward Air Controller, Airborne
FDC	Fire Direction Center
FEX	Field Exercise
FFE	Fire For Effect
FO	Forward Observer
FSCC	Fire Support Coordination Center
FSR	Fire Support Routine
G/S (GS)	General Support
GT	Gun-to-Target
GTRG	Gun-to-Target Range
LF	Landing Force
MAB	Marine Amphibious Brigade



MAG	Marine Air Group
MAU	Marine Amphibious Unit
MAXORD	Maximum Ordinate
MCDEC	Marine Corps Development and Education Command
Msg	Message
Msn	Mission
NELC	Naval Electronics Laboratory Center
NGF	Naval Gunfire
OPTRG	Optimum Maximum Range
OT	Observer-to-Target
PED	Probable Error, Deflection
PER	Probable Error, Range
Regt	Regiment
RFP	Restrictive Fire Plan
RG	Range
SFCP	Shore Fire Control Party
TACC	Tactical Air Command Center
TESE	Tactical Exercise Simulator and Evaluator
TGT	Target
TWAES	Tactical Warfare Analysis and Evaluation System
TWSEASS	Tactical Warfare Simulation Evaluation and Analysis Systems Study



## GLOSSARY

- AIM POINT** - As used within this paper, that point on the ground which is used to compute firing data for the weapons involved. It is normally the target location offset by some observer error.
- BATTALION LANDING TEAM** - In an amphibious operation, an infantry battalion normally reinforced by necessary combat and service elements; the basis unit for planning an assault landing.
- CENTRALIZED FIRE DIRECTION** - The method of fire direction whereby tactical or tactical and technical fire direction is at the battalion level.
- COMMANDER AMPHIBIOUS TASK FORCE** - The senior Naval officer who commands the entire amphibious operation, to include the landing force as well as Naval components.
- COMMANDER LANDING FORCE** - The commander of the highest troop echelon in the amphibious operation, which includes both aviation and ground units.
- COMMAND POST EXERCISE** - An exercise involving the commander, his staff, and communications within and between headquarters.
- DECENTRALIZED FIRE DIRECTION** - The method of fire direction whereby technical or technical and tactical fire direction is delegated to the firing unit (battery/platoon) level. For the purposes of this paper, it is used to denote decentralization of both technical and tactical control.
- DIRECT AIR SUPPORT CENTER** - A subordinate operational component of the tactical air control system designed for control and direction of close air support and other direct air support operations. It is under the operational control of a tactical air control or tactical air direction center and is normally located near the command post of the supported ground unit.





DIRECT SUPPORT - A mission requiring a force to support another specific force and authorizing it to answer directly the supported force's request for assistance.

DIRECT SUPPORT BATTALION - Those battalions within the Marine artillery regiment that are normally assigned a mission of direct support of an infantry regiment. The 105mm Howitzer batteries are within these battalions.

FORWARD AIR CONTROLLER (AIRBORNE) - An officer (aviator) member of the tactical air control party/air control team who, from a forward (airborne) position, controls aircraft engaged in close air support of ground troops.

FIELD EXERCISE - An exercise conducted in the field under simulated war conditions in which troops and armament of one side are actually present, while those of the other side may be imaginary or in outline.

FIRE DIRECTION CENTER - That element of a command post, consisting of gunnery and communication personnel and equipment, by means of which the commander exercises fire direction and/or fire control. The fire direction center receives target intelligence and requests for fire, and translates them into appropriate fire direction.

FIRE SUPPORT COORDINATION CENTER - A single location in which are centralized communications facilities and personnel incident to the coordination of all forms of fire support. It is an element within the supported unit's command post.

GENERAL SUPPORT - That support which is given the supported force as a whole and not to any particular subdivision thereof.

GRID - A term used in giving the location of a geographic point by grid coordinates.

IMPACT POINT - That point at which fire actually lands, as compared to the aim point.



**MARINE AIR GROUP** - An administrative and tactical command element within Marine aviation, consisting of a headquarters and maintenance squadron, and airbase squadron, and two or more aircraft or helicopter squadrons.

**MARINE AMPHIBIOUS BRIGADE** - A Marine air-ground task force built around a regimental landing team and a Marine aircraft group. The Marine amphibious brigade normally employs about one-third of the combat resources of one Marine division/wing team.

**MARINE AMPHIBIOUS UNIT** - A Marine air-ground task force built around a battalion landing team and a provisional Marine aircraft group which is usually composed of an attack squadron and a helicopter squadron. The Marine amphibious unit normally employs about one-ninth of the combat resources of one Marine division/wing team.

**MAXIMUM ORDINATE** - The highest point along the trajectory of a projectile. The difference in altitude (vertical interval) between the origin and the summit.

**NAVAL GUNFIRE SPOT TEAM** - The unit of a shore fire control party which designates targets, controls commencement, cessation, rate and types of fire, and spots fire on the target.

**NO-FIRE LINE** - A line short of which artillery or ships may not fire except on request or approval of the supported commander, but beyond which they may fire at any time without danger to friendly troops.

**PRE-PLAN (PRE-PLANNED TARGET)** - A term used within this paper to denote a target against which fires are formally planned in advance of execution. It may be pre-planned as to location only (On-Call) or to both time and location. Within the fire support routine logic, pre-plan designates an on-call status.



**PRIORITY OF FIRES** - A method whereby the commander of a supported unit can modify the normal precedence among subordinate units for requesting support to provide additional weight to a particular element. The requests from the so designated unit have priority over requests from other units within the larger command.

**REINFORCING** - A tactical mission in which one artillery unit augments the fires of another artillery unit.

**RESTRICTIVE FIRE PLAN** - A safety measure for friendly aircraft which establishes airspace that is reasonably safe from friendly surface delivered nonnuclear fires.

**ROUNDS ON TARGET** - A term used within the scope of this paper to signify the time that the fire for a requested mission will be delivered on the target.

**SCHEDULE OF FIRE** - Groups of fires or series of fires fired in a definite sequence according to a definite program. The time of starting the schedule may be on-call. For identification purposes schedules may be referred to by a code name or other designation.

**SHORE FIRE CONTROL PARTY** - A specially trained unit for control of naval gunfire in support of troops ashore, consisting of a spotting team to adjust fire and a naval gunfire liaison team to perform liaison functions for the supported battalion commander.

**TACTICAL AIR COMMAND CENTER** - The principal United States Marine Corps air operation installation from which aircraft and air warning functions of the tactical air operations are directed. It is the senior agency of the Marine Corps Air Command and Control System from which the Marine Corps tactical air commander can direct and control tactical air operations and coordinate such air operations with other services.

**TACTICAL FIRE DIRECTION** - Tactical fire direction is the exercise of tactical command of one or more units in the selection



of targets, the designation of units to fire, and the allocation of ammunition for each mission.

**TECHNICAL FIRE DIRECTION** - Technical fire direction is the conversion of calls for fire to appropriate firing data and fire commands.





## I. THE REQUIREMENT

Historically, most of the military professionals' time has been devoted to training. Modern information, collection and transmission systems, complicated and costly weapon systems, and the tremendous growth of the interaction of the various facets of warfare among themselves have introduced new dimensions to the problem facing today's military. These same factors have made it more difficult to provide this training.

The commander now requires a large staff to process the raw data fed continuously through the command structure. These staffs must be trained, but the most common methods either require the expenditure of large amounts of weaponry, or lack realism. Thus, new methods must be developed which will place realistic pressures on the commander and his staff, allow meaningful interpretation of the results, and minimize the amount of support needed.

### A. PRESENT METHODS

#### 1. Field Exercise (FEX)

The FEX is a costly affair. Three units must be placed in the field -- to provide training for only one of them: a unit of company size or larger to be trained; an "aggressor" unit to provide a force against which to interact; and an umpire, or control, unit to determine what would be a realistic outcome of a sequence of actions. Due to the interdependence of so many factors, the control unit must be extremely large if any fidelity



is expected, and even then it is difficult to simulate all the input which would be encountered in a combat situation.<sup>1</sup>

## 2. Command Post Exercise (CPX)

The CPX is a technique used for staff and individual training. A command post is established with all the communications normally utilized, and the staff interacts with the message traffic which simulates the activities of the units in the field. The cost of the CPX is less than that of the FEX, but the control organization has even greater requirements placed upon it. Not only are all the simulations of the FEX still needed, but all troop and equipment activity must be generated artificially. Extensive decision rules must be prepared to give guidance for the multitude of situations which might develop.

## B. TESE

In order to utilize modern technology to assist in training, the Tactical Exercise Simulator and Evaluator (TESE) Project was established in October 1969.<sup>2</sup> This project was to "develop a computer-assisted

---

<sup>1</sup> A sister project of TESE, the Tactical Warfare Analysis and Evaluation System (TWAES), is approaching this problem by focusing the control organization about a computer-assisted information system. Both projects are formed into a single coordination group in the Tactical Warfare Simulation Evaluation and Analysis Systems Study (TWSEASS) Project, and have a great number of similarities in concept. The main difference is that TWAES is to provide a system for unit training, while TESE is for staff training and individual education within the formal schools systems.

<sup>2</sup> Commandant of the Marine Corps Letter A03C52-1jh: to Commanding General, Marine Corps Development and Education Command, Subject: Project Directive For Tactical Exercise Simulator And Evaluator, 30 October 1969.



war game -- the TESE -- to be used for the education and evaluation of ground combat commanders and their staffs." <sup>3</sup> It would be a game capable of "open dynamic play characterized by the systems ability to receive for execution any plan formulated by the commander and his staff and to receive subsequent changes to that plan as the situation develops, limited only by the area of operations, available forces and weaponry," and "two-sided play which allows concurrent practice in both the offensive and defensive roles." "Simulation models for movement, fire power assessments, weaponry limitations, terrain, target acquisition, logistics, communications, and personnel will be included." <sup>4</sup>

TESE was to be developed in phases, with the objective of each phase the development of a complete model which could be modified to fit into the final simulation. It was "envisioned that the modular approach to development of a Ground Combat Simulator will provide an expansive capability vertically and horizontally. Vertical expansion will involve a program which will include training from the basic officer level through Command and Staff College level. Horizontal expansion will expand the ground combat concept into amphibious exercise and integration with naval warfare." <sup>4</sup> Basically a two-sided game, modification would enable a

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<sup>3</sup> Commandant of the Marine Corps Letter AX/A03C51-lag: to Commanding General, Marine Corps Development and Education Command, Subject: Tactical Warfare Simulation, Evaluation and Analysis Systems Study and Management Project Directive, 20 January 1972.

<sup>4</sup> Commandant of the Marine Corps Letter A03C51-sl: to Commanding General, Marine Corps Development and Education Command, Subject: Advanced Development Objective (ADO) No. CT-01X: Tactical Exercise Simulator and Evaluator (TESE), 6 May 1971.



staff to "play against the machine" in a one-sided game. It would also be possible to construct the simulation to allow for the selection of various levels of resolution within each of the functional areas, in order to exercise one portion of the staff in greater depth. New dimensions have been added to the training requirement but technology can also add to the training capability.

#### C. PURPOSE OF THIS PAPER

The purpose of this paper was to develop the fire support systems logic flow and initial input parameters for the Phase III, Marine Amphibious Unit (MAU) level model which was to be employed during the class number 0413 at the Amphibious Warfare School (AWS), in January 1973. This work was done in coordination with the Marine Corps Development Center, Marine Corps Development and Education Command, Quantico, Va., and the Naval Electronics Laboratory Center (NELC), San Diego, California. The logic flow and input parameters were provided to NELC for use and modification, as required.

#### D. ORGANIZATION

Chapter II outlines the purpose of 0413 at AWS and the relationship to TESE. Chapter III outlines the combat organization to be used and how the supporting arms systems function within this organization. IV is the flow logic provided NELC, and V are some of the modifications which were made prior to implementation. VI discusses some of the work still to be done for inclusion with the advanced versions of TESE.





## II. 0413

### A. AMPHIBIOUS WARFARE SCHOOL (AWS)

AWS, a formal school in the Education Center, Marine Corps Development and Education Command (MCDEC), is a six-month course for senior captains and junior majors. It is the second in a sequence of formal Marine Corps schools, and emphasizes the role of the staff officer at battalion and regimental level. Officers are instructed in order preparation, staff coordination and functioning, and execution of the amphibious assault planning and operations. The culmination of the course of instruction is a three-day amphibious planning CPX, with a Marine Amphibious Brigade (MAB) tasked to land on an enemy held island. Students function in the roles of commanders at battalion level and staffs at battalion, regimental and amphibious task force (ATF) levels.

### B. TESE AND 0413

It was decided to prepare the first implementation of any portion of TESE for the final CPX at AWS -- A(A) 0413. This implementation was not intended to be the complete MAB model, but a testing MAU model to indicate possible problem areas, provide some experience measuring student performance changes from the old CPX, and to introduce the concept into the instructional system. A shortage of time greatly limited the degree



of sophistication which could be achieved by the target date,<sup>5</sup> but the objectives could be met by a simple model. Furthermore, the requirement was: "Although it is unnecessary for simulated activities to meet the criteria of ground truth, they must be of sufficient reasonableness to ensure acceptance by the student."<sup>6</sup> Thus effort could be devoted to developing a "reasonable" model knowing it would need improvement.

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<sup>5</sup>The Design Specifications Study was not published by the contractor until April of 1972, leaving only seven months to develop the entire flow logic and most of the input parameters, if it was to be debugged and on line by December 1972.

<sup>6</sup>Commandant of the Marine Corps Letter A03C51-sl: to Commanding General, Marine Corps Development and Education Command, Subject: Advanced Development Objective (ADO) No. CT-01X: Tactical Exercise Simulator and Evaluator (TESE), 6 May 1971.



### III. FIRE SUPPORT LOGIC REQUIREMENT

#### A. MAB STRUCTURE

A MAB consists of: a reinforced infantry regiment of three or more battalions; an artillery unit, normally a direct support battalion reinforced with general support units; a Marine Air Group (MAG); and other smaller supporting units. It is essentially a self-sufficient organization capable of sustained ground combat operations. It is integrated into the ATF which includes a naval component with sufficient surface shipping to carry the MAB, naval gunfire support ships, and other ships necessary for the planned operations.

The weaponry within the MAB provides the rifleman with a flexible response to a wide variety of situations and target types. In addition to the weapons of the rifle platoon, the company has organic (60 mm) mortars, machineguns and anti-tank weapons. At the battalion level are 81mm mortars, 106mm recoilless rifles, and flame throwers. The supporting artillery will normally include one 105mm howitzer battery for each infantry battalion and general support units such as a 155mm howitzer battery and/or one to three platoons of 8 inch howitzers or 175mm guns. A typical naval gunfire support organization would include one direct support ship (destroyer) assigned to each battalion and a general support ship (destroyer/cruiser) assigned to the regiment. The MAG could be tailored with any mix of aircraft deemed appropriate to the situation, but, in general, included will be a large percentage of close support aircraft.



## B. SUPPORTING ARMS COMMUNICATIONS FLOW

Supporting arms communications is defined for the purposes of this paper as those communications necessary for the supported infantry to obtain 81mm mortar, artillery, naval gunfire, and close air support. Prior to the transfer of responsibility for coordination of supporting arms ashore, the commander of the amphibious task force (CATF) retains control through a shipboard organization which is beyond the scope of this work. Once this responsibility has been transferred to the commander of the landing force (CLF), the flow is as outlined below.

### 1. Mortars/Artillery

Each rifle company is provided with forward observers from one of the 105mm howitzer batteries and from the battalion's 81mm mortar platoon. These observers normally originate the requests for support for the company, sending the request directly to the supporting unit. The infantry battalion commander, through his Fire Support Coordination Center (FSCC), coordinates these requests, and must at least implicitly approve all fires within his assigned area. (In special type operations, a mortar or artillery unit may be attached directly to an infantry unit, and the approval procedure is modified to fit the situation.)

### 2. Air

Within each battalion are two forward air control (FAC) teams. These teams are assigned to those companies which the battalion commander feels require and can best utilize air support. The FAC team will submit their requests directly to the Direct Air Support Center (DASC)





which controls the air assets assigned for close air support. Again, the battalion commander exercises approval authority through the FSCC which monitors all requests. Airborne controllers (FAC(A)) may be used to supplement the ground controllers.

### 3. Naval Gunfire

The direct support artillery battalion, in addition to tasking one of the 105mm howitzer batteries to provide forward observers to each of the infantry battalions, provides two shore fire control parties (SFCP) to the infantry regiment. This SFCP consists of a liaison team, to operate in a battalion FSCC and advise the battalion commander in naval gunfire support matters, and a naval gunfire spot team, which can be assigned to one of the companies. The naval gunfire spot team establishes communications with the assigned direct support ship in the same manner as the artillery observer does with the direct support artillery battalion.

### 4. Modifications

All of the infantry-supporting arms relationships may be modified to fit the situation at the discretion of the CLF. Within all systems there will be provisions for entry from a wide variety of sources and under varied circumstances. For example, while the normal procedure to obtain artillery support is through the communications provided with the artillery forward observer, the company commander may find it necessary to send a request through the infantry communications system, to the FSCC and have it relayed to the direct support artillery battalion.

(Appendix A is a detailed flow diagram of the flow of requests for supporting arms within the Marine combat organization.)



### C. LOGIC TO BE DEVELOPED

Appendix B is the initial Fire Support System proposal submitted to the TESE project officer and approved by him and the instructors involved with 0413. At company level, the weapon selection logic would be simulated, and requests for support generated. Upon student (FSCC) approval, the delivery of mortar, artillery, or naval gunfire would be simulated (to include the selection of a unit to fire, which is a function of the supporting organization), and the number of rounds as well as the times of delivery would be generated. Requests for air support would be submitted to students functioning in the role of the DASC who would input the amount and time of ordnance delivery.



#### IV. FIRE SUPPORT SYSTEM LOGIC (PROPOSED)

Two separate fire support systems were developed and proposed for use in 0413 in January 1973; one for the landing force (LF) and one for the aggressors (AG). The AG system is merely a bookkeeping system to relieve the instructor (umpire or controller) of the need to monitor all enemy fire support requirements, and still provide a reasonable response.

##### A. LF SYSTEM

###### 1. Organization

The LF system is broken into five major subroutines controlled by the Main Fire Support Routine, and a number of minor subroutines called from within the fire support system logic. The five major subroutines each simulate a portion of the fire support system.

###### a. Weapon Selection Routine

This routine simulates the logic at company level and selects a weapon to fire on a given target. The output of the routine is a request for support.

###### b. Artillery Unit Selection Routine

Given a request for artillery support, the Unit Selection Routine simulates the logic within the artillery organization. Any delays within this organization are assessed at this point. The output is a unit to fire and the time at which the unit would receive the mission.



c. Mortar Shoot Routine

This is the simulation of the logic within the infantry mortar platoon organization. The output is a section to fire, the number of rounds to fire in effect, and the time of fire for effect.

d. Artillery Shoot Routine

Once an artillery unit has been selected to fire, the Artillery Shoot Routine provides the bookkeeping capability to monitor artillery ammunition status, simulates the logic within the artillery organization selecting the number of rounds to fire, and requests reinforcing fires for large missions. The output is the number of rounds and time of fire for effect.

e. Naval Gunfire Shoot Routine

Naval gunfire missions are sent directly to a particular ship, but a battery must be selected. This routine simulates that logic and determines the number of rounds. The output is the caliber firing, the number of rounds in effect, and the time of fire for effect.

2. Functioning

a. Entry

The Fire Support Routine (FSR) is entered from one of two points: from the detection program, when it is determined that a LF unit detects or is in contact with an AG unit; or from an external requirement for fire, generated by the students in their capacity as the FSCC or by the instructor.





b. Main Fire Support Routine (Figure 1)

Main Fire Support is the control routine that coordinates the flow of missions. Upon initial detection or contact, a mission number is assigned for each AG unit involved and the Weapon Selection Routine is called. Once a weapon is selected, a message is sent to the FSCC (student players) for approval. If approved, the mission is sent to the appropriate shoot or Artillery Unit Selection Routine. If not approved, the mission is deleted from the file. For a subsequent detection the following checks are made:

(1) Is there a mission number for this event? If not, it means that the FSCC has denied the initial request, and control is returned to the detection program.

(2) Has fire for effect (FFE) been completed? If the game time is less than the rounds on target, it means that FFE has not been completed, and control is returned to the detection routine.

(3) Is the range greater than that of initial detection? If it is, the LF unit is moving away from the AG unit, a second FFE will not be delivered, and control is again returned to the detection program.

For subsequent contacts, only checks (1) and (2) are made, since the units do not move during contact. If FEE has been completed, another FFE is initiated, otherwise control is returned to the contact program.



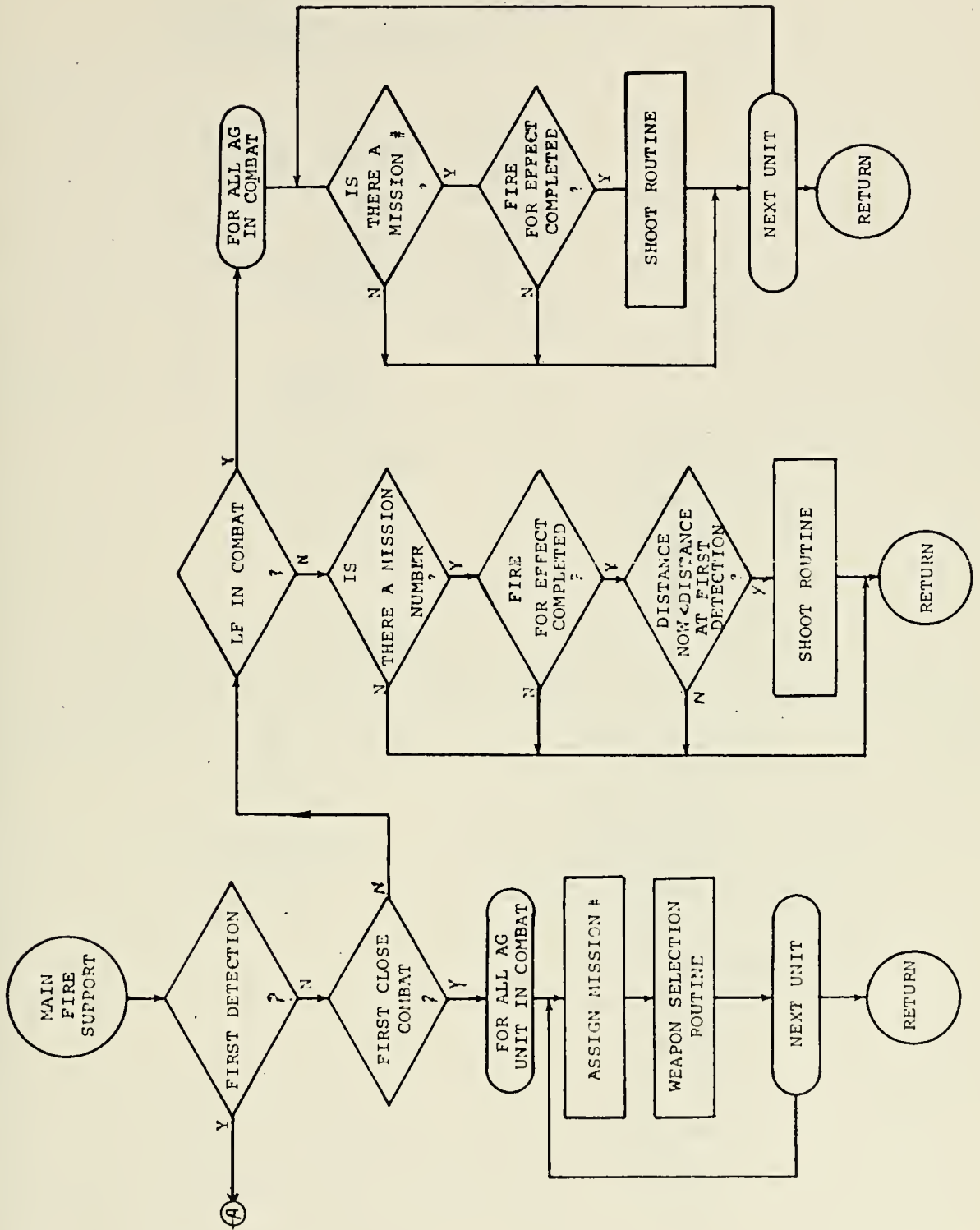


Figure 1 - Main Fire Support Routine



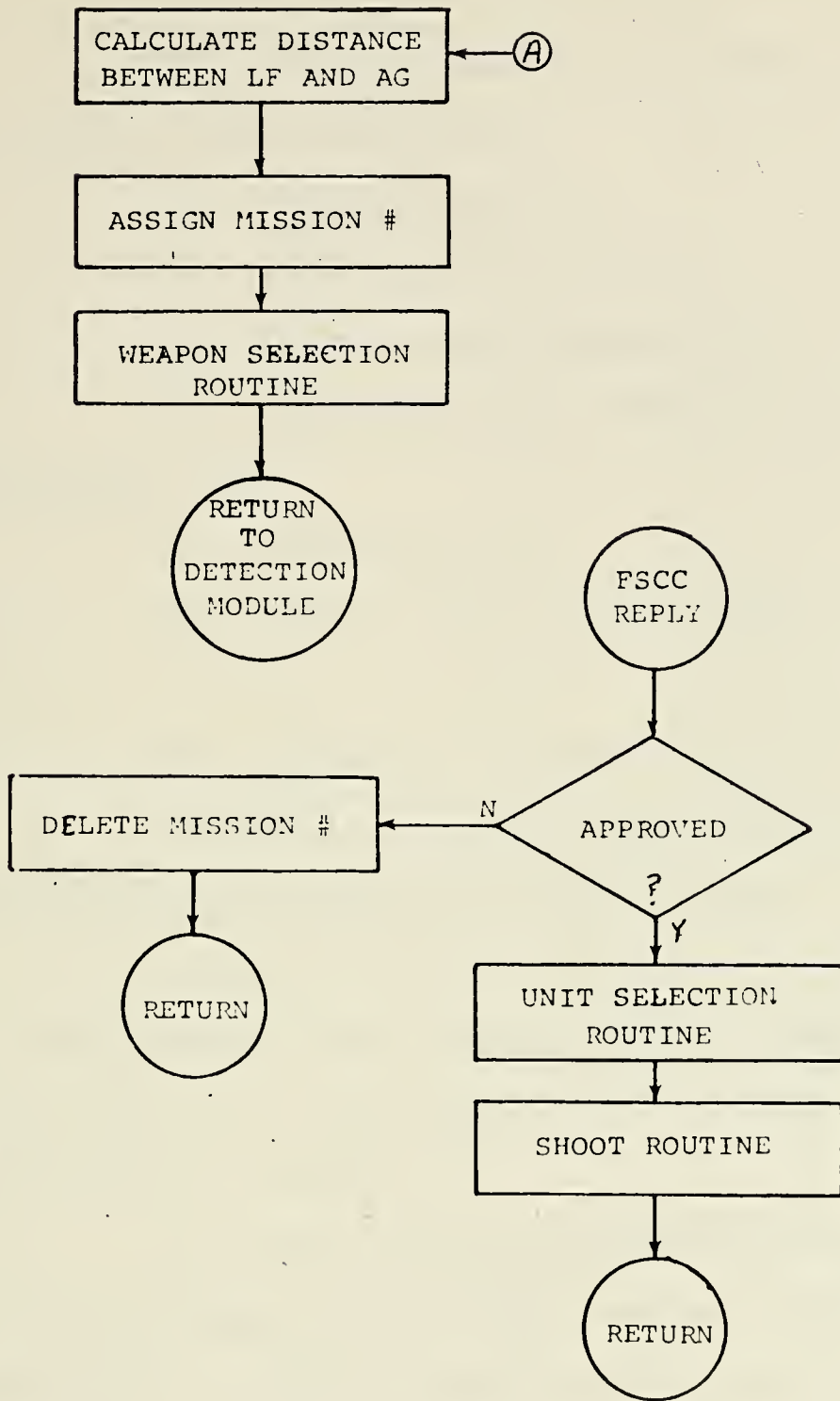


Figure 1 - Part 2



c. Weapon Selection Routine (Figure 2)

Within the Weapon Selection Routine, targets are initially sorted into one of seven categories:

- (1) Infantry in the open (= a)
- (2) Infantry in hasty defense (= b)
- (3) Infantry in prepared positions (= c)
- (4) Armor (includes infantry with tanks and self propelled artillery) (= d)
- (5) Towed artillery (= e)
- (6) Infantry in armored personnel carriers (APCs) (= f)
- (7) Support units, or infantry in trucks (= g)

The mission is assigned to a particular weapon system based on the target type, range and availability of observers.

A priority is assigned on a 1 to 5 scale to provide a means of allocating assets if units are fully engaged. It is dependent upon target type and size, distance between the LF and the target and whether the LF unit is in contact.

It is assumed that the observers for mortar and artillery units are always available. The naval gunfire spot teams and forward air controllers (FACs) are considered available only when attached to the company. Airborne FACs are not considered.

If a mission is to be fired by an attached mortar section, it is assumed that the company commander will utilize the section without FSCC approval.





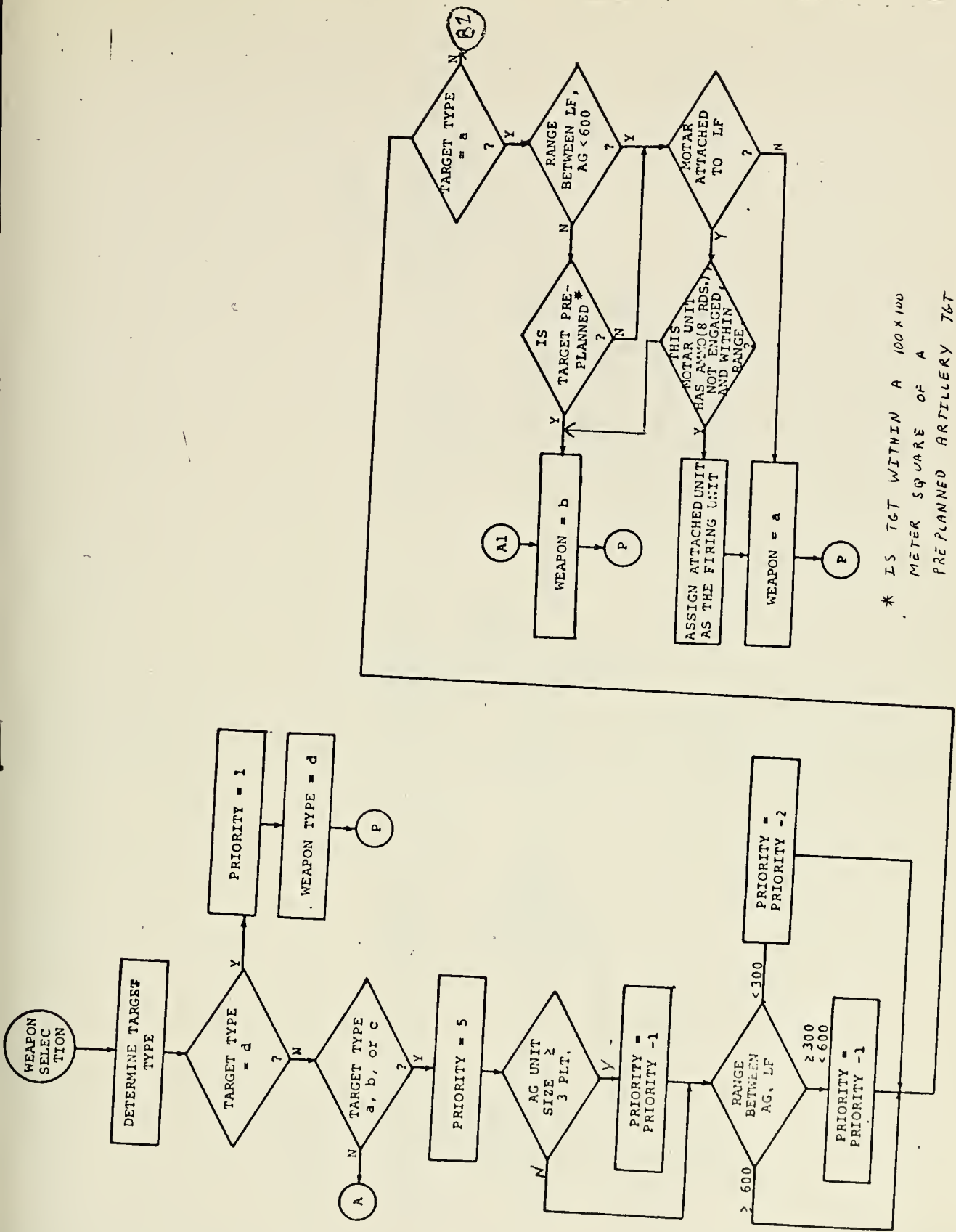


Figure 2 - Weapon Selection Routine



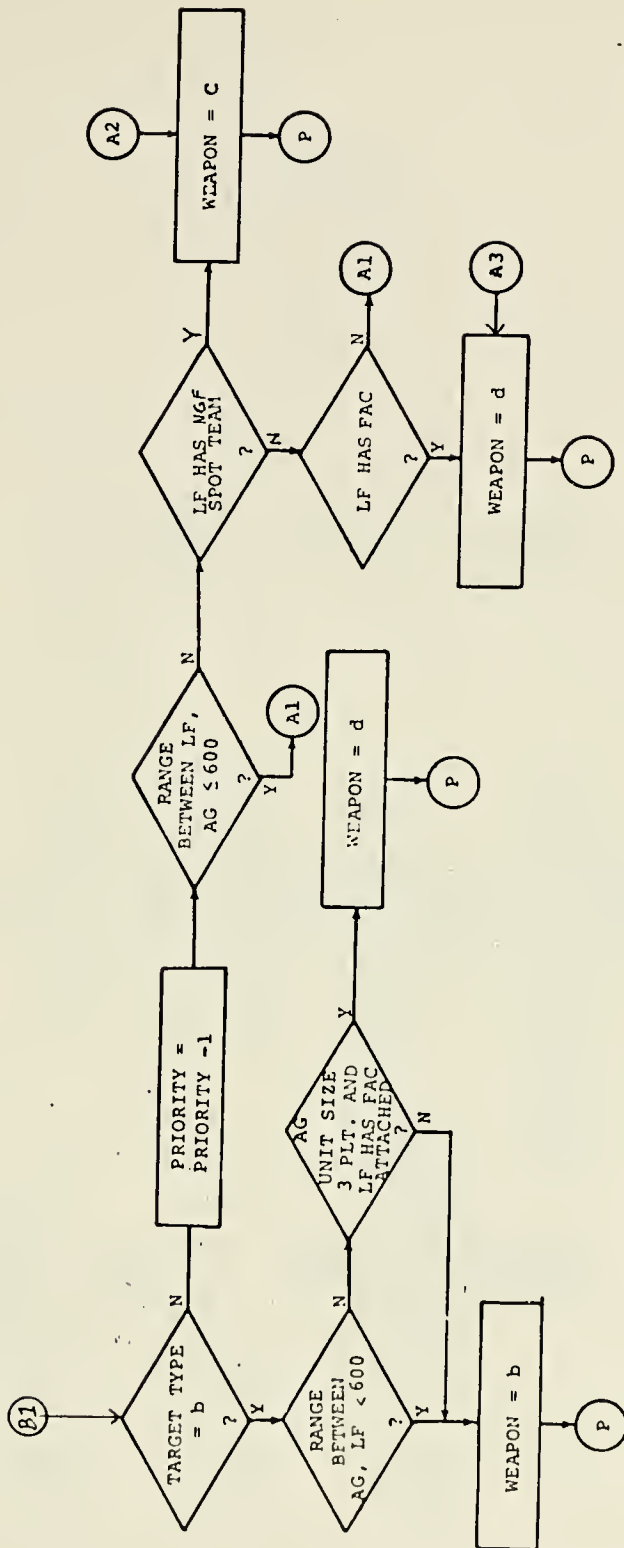


Figure 2 - Part 2



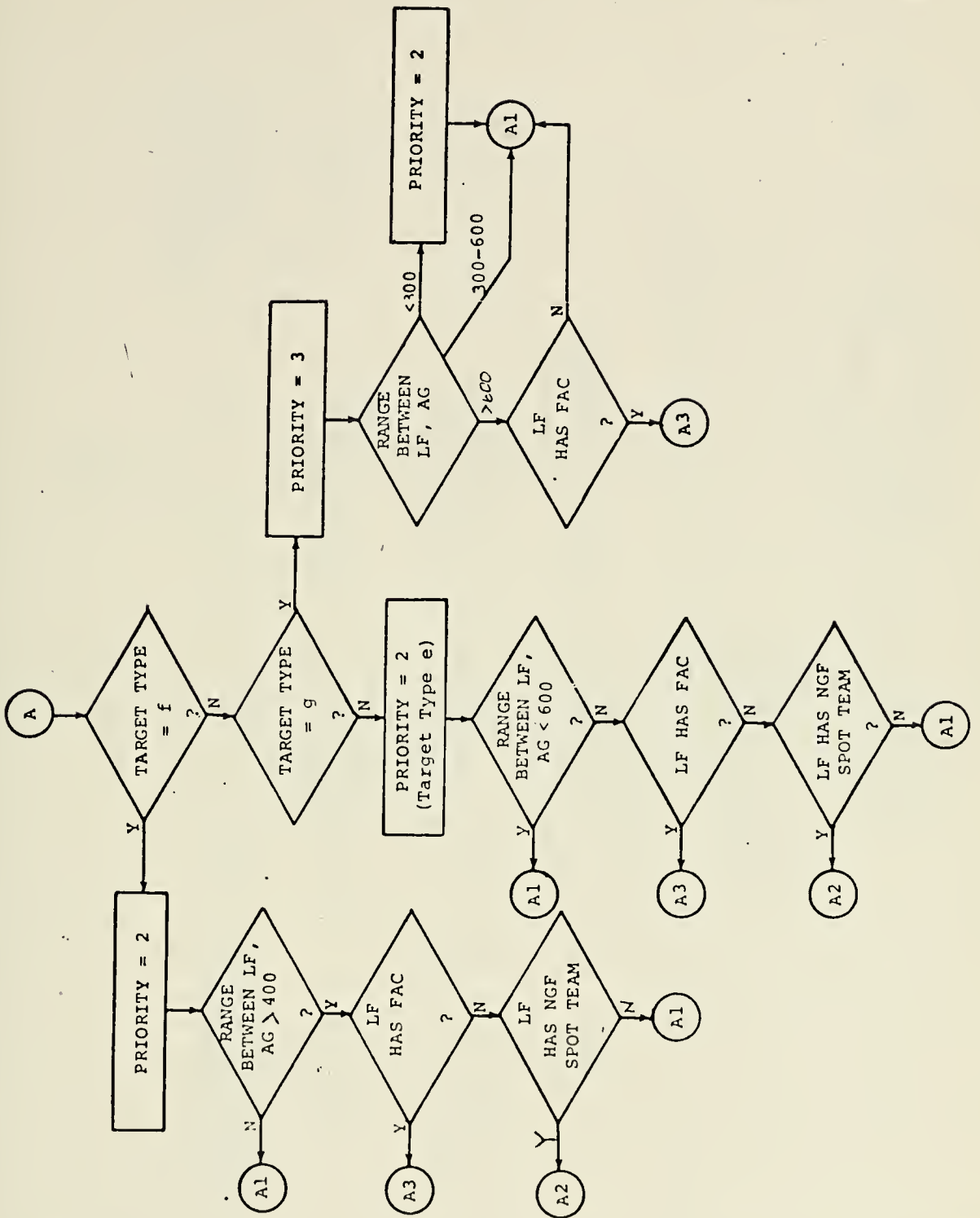


Figure 2 - Part 3



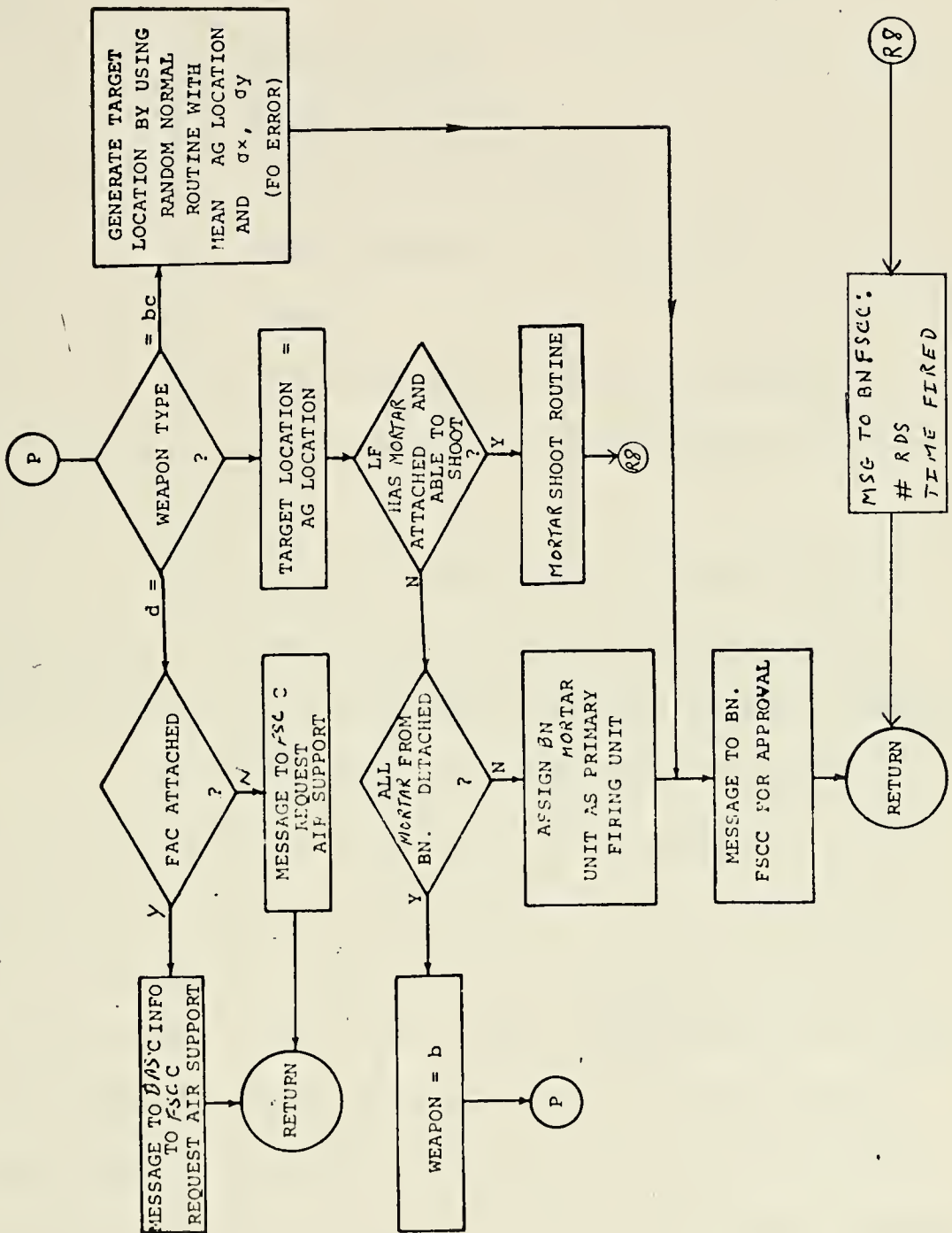


Figure 2 - Part 4





After selecting the weapon system to be used for the mission, a message is sent to the Bn FSCC for approval. The message contains:

- (1) Mission number
- (2) Requesting unit ID
- (3) Weapon system requested
- (4) Enemy location
- (5) Priority

The FSCC must approve or disapprove (cancel) the mission, and has the option of changing the supporting arm or priority if the mission is approved.

The requested location for air and mortar missions is the target location. For these weapons systems, no delivery error is computed, and the aim point and impact point will be the target location.

For artillery and naval gunfire missions, observer error and round dispersion is included in initial impact points. The FO error and dispersion errors are both assumed to be random normal distributions, with standard deviations functions of observer-to-target and gun-to-target ranges, respectively. When a mission circuits the Weapon Selection Routine for artillery and naval gunfire, the observer error is computed and the target location is modified by this amount to provide the requested location which is sent to the FSCC. (For student originated missions, the requested location is that submitted and dispersion errors are computed as below.) For the first round, either in adjustment for



"observer" (i.e. machine) missions, or for FFE for student missions, the requested location is used as the aim point and is modified by dispersion effects to determine the impact point. Following the first round(s), the aim and impact points are the target location. (Student originated missions will not have additional rounds.)



d. Artillery Unit Selection Routine (Figure 3)

(1) General. The Artillery Unit Selection Routine is designed to accept missions of various priorities and assign them to firing units of a Direct Support Artillery Battalion (reinforced). The Direct Support Artillery Battalion is composed of: four 105mm howitzer batteries, one 155mm howitzer battery, and three 8-inch howitzer platoons.

The selection logic considers, among other factors, attachment of firing units, units assigned a mission of reinforcing, and centralized or decentralized battalion FDC.

Further considerations in the program logic are:

(a) Each 105 battery is either attached to or providing forward observers to an infantry battalion.

(b) Priority of assignment is first to 105 batteries, then 155 batteries and finally to 8-inch platoons, for all missions, including requests for reinforcing fires generated during close combat.

(c) Some infantry units may be assigned priority of fires.

(d) No artillery fire is delivered which will pass through a restrictive fire plan. Specifications of the plans are student input in the program. (See IV.C.3 for description of the Restrictive Fire Plan Logic.)



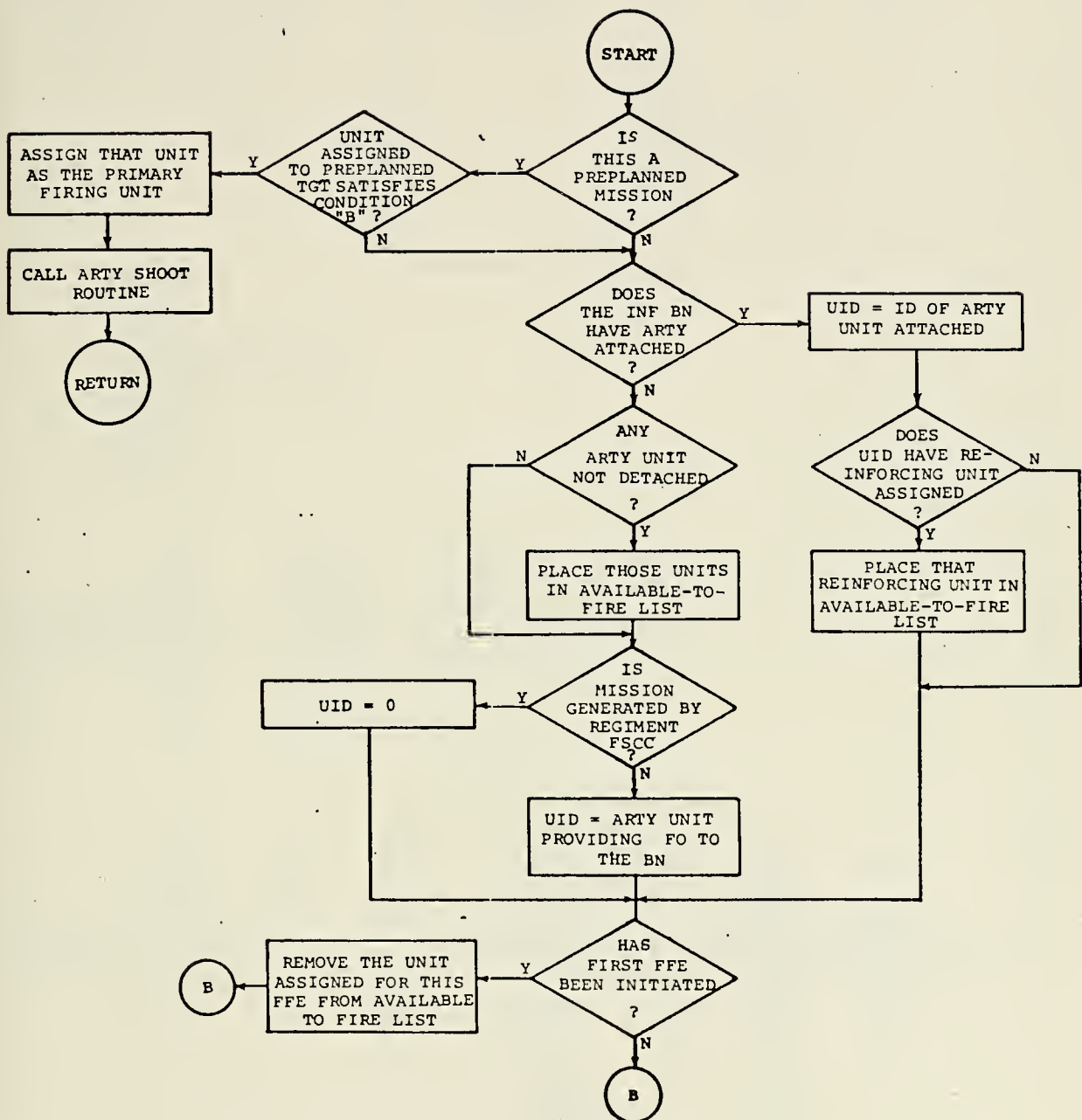


Figure 3 - Artillery Unit Selection Routine





**CONDITION A:**

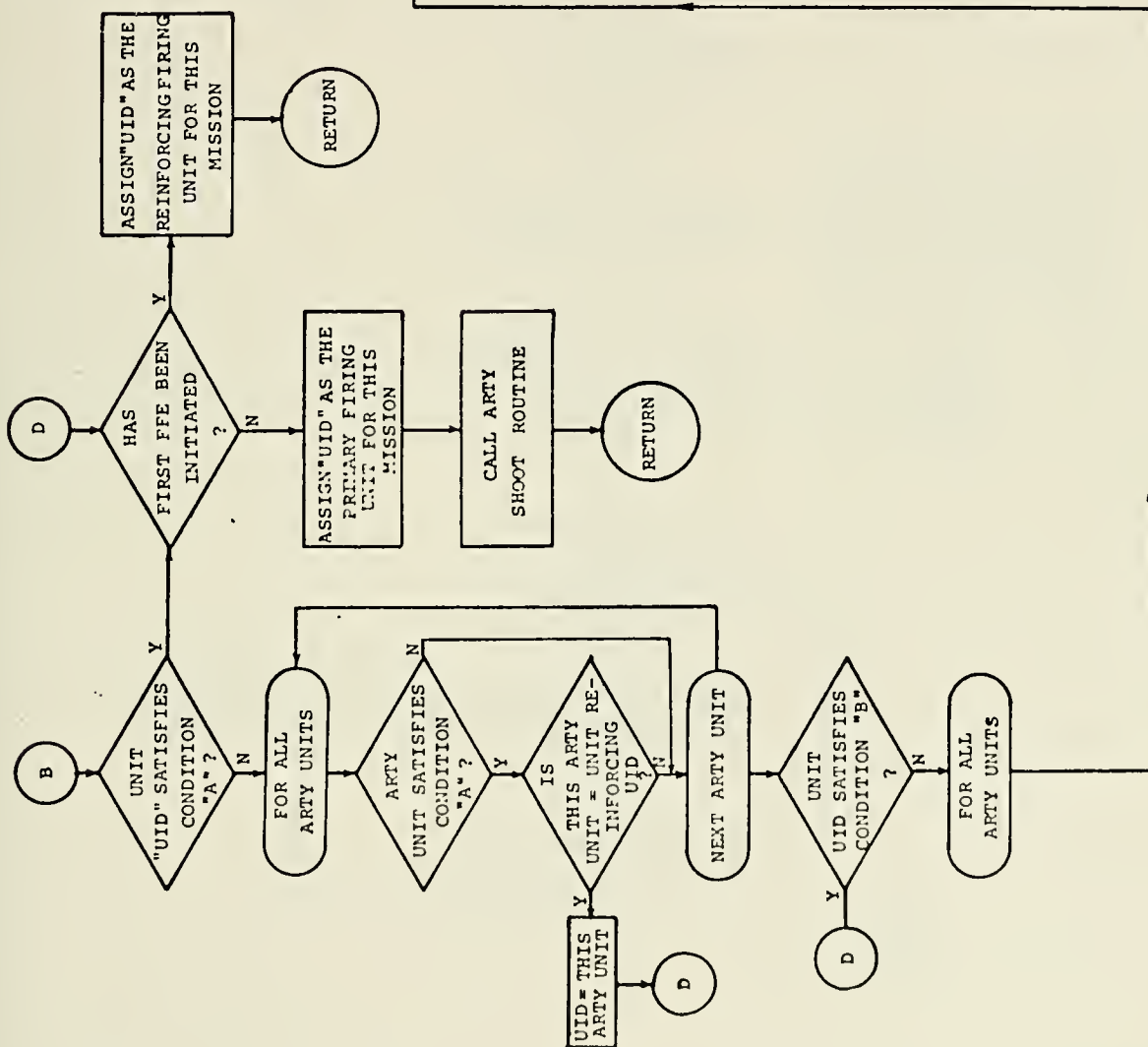
1. ON AVAILABLE-TO-FIRE LIST
2. NOT MOVING
3. AMMO AVAILABLE
4. WITHIN RANGE TO TARGET
5. NOT RESTRICTED BY KFP
6. NOT ENGAGED IN OTHER MISSION
7. RANGE TO TARGET IS LESS THAN THE GUN OPTIMAL RANGE

**CONDITION B:**

SAME AS CONDITION A EXCEPT "7"

**CONDITION C:**

SAME AS CONDITION A EXCEPT "6" AND "7"



\* IN CASE 3, NO UNITS ARE ASSIGNED REINFORCING UID.

Figure 3 - Part 2



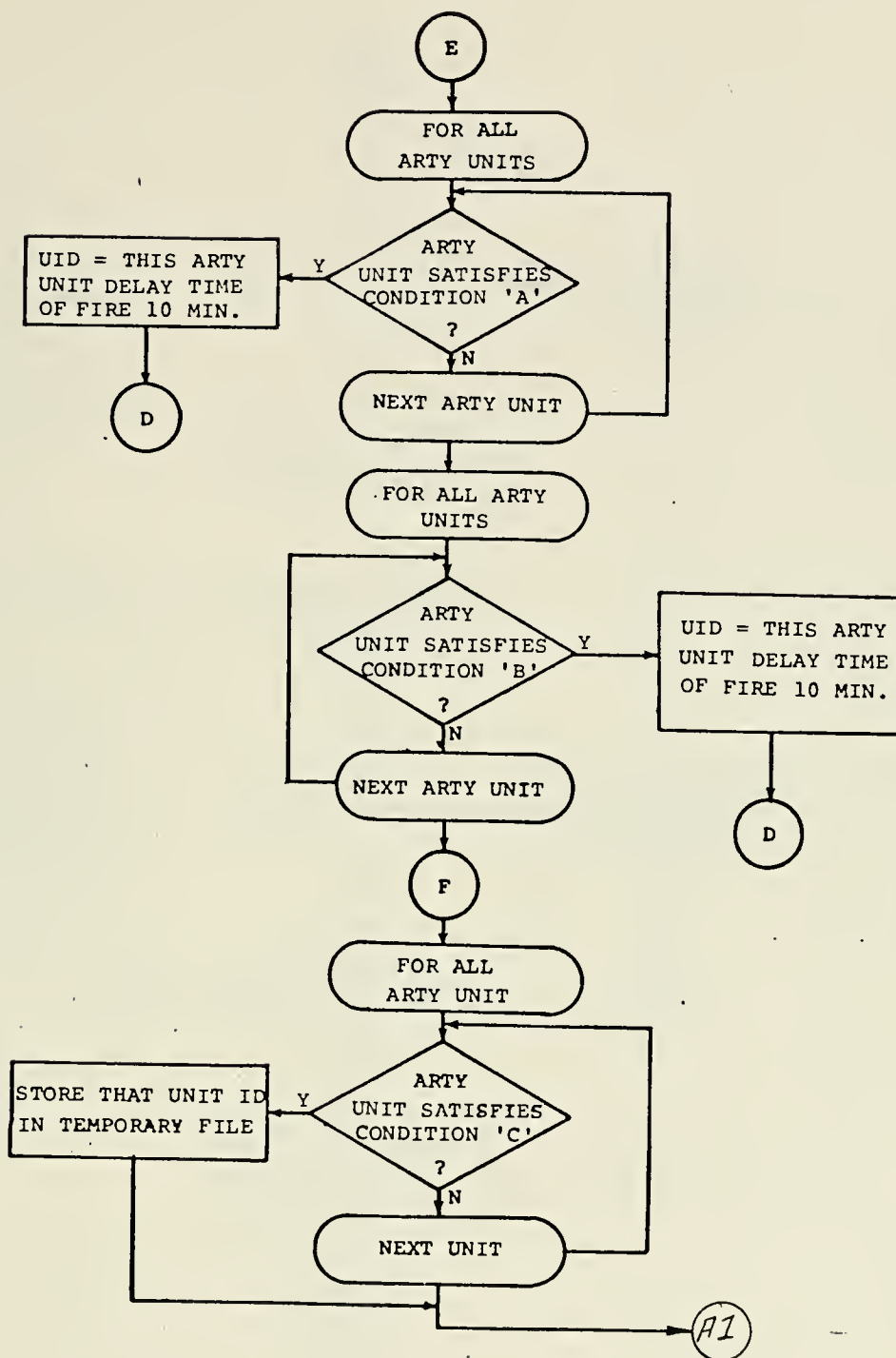


Figure 3 - Part 3



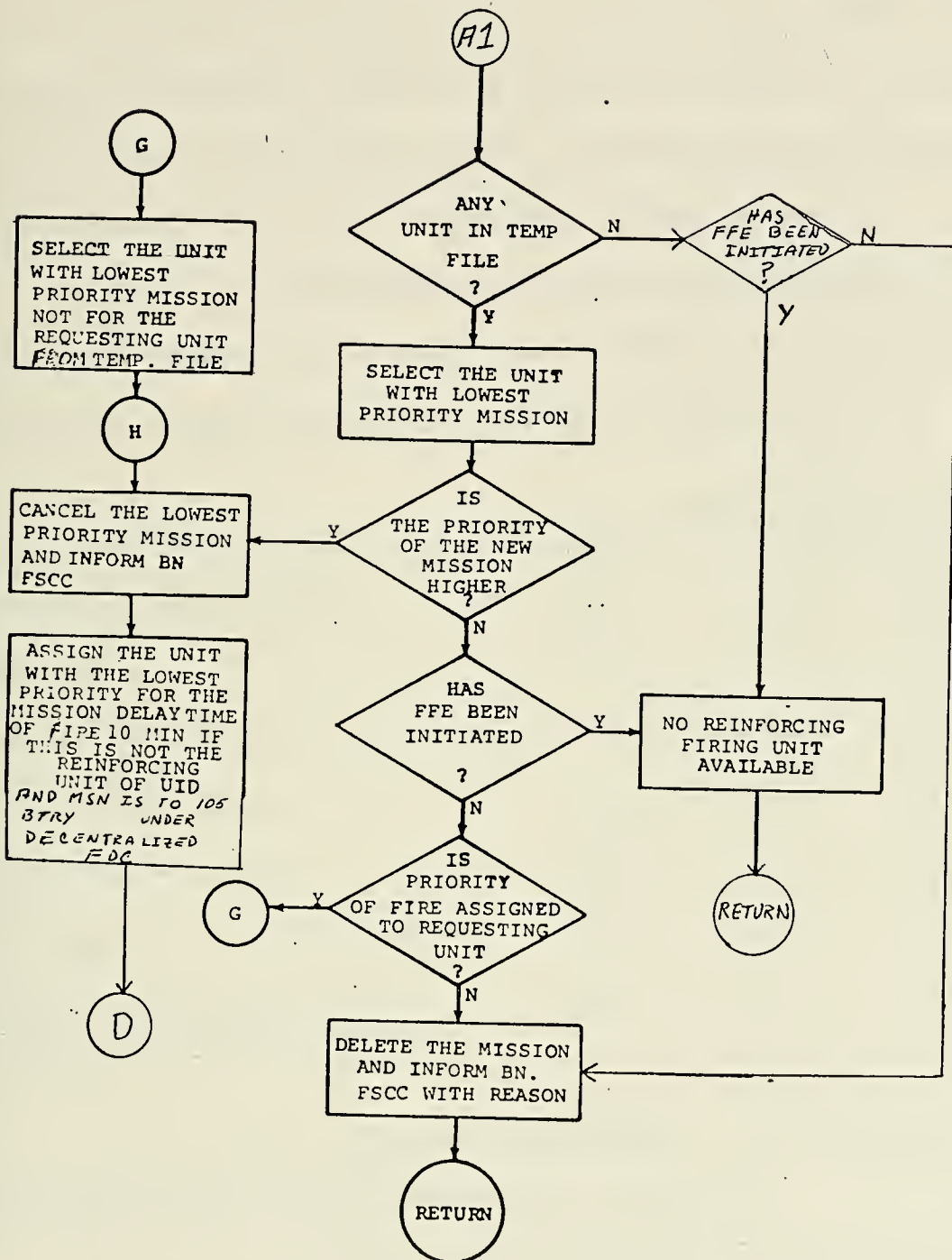


Figure 3 - Part 4



The Artillery Unit Selection Routine is called when artillery is selected for the mission by the Weapons Selection Routine or by the student and the cognizant FSCC has approved the mission. The routine will determine a primary firing unit for the mission. It is called by the Artillery Shoot Routine to select a reinforcing firing unit when three fire for effects have been completed by the primary firing unit.

At certain points in the logic, selection of the unit to fire requires satisfaction of one of three conditions. Each condition constitutes a specific combination of criteria, outlined below.

Criteria	Condition		
	A	B	C
On Available-to-fire list	Yes	Yes	Yes
Not moving	Yes	Yes	Yes
Ammunition available	Yes	Yes	Yes
Within range to target	Yes	Yes	Yes
Not restricted by RFP	Yes	Yes	Yes
Not engaged in other missions	Yes	Yes	No
Distance to target is less than the gun optimal maximum range	Yes	No	No

(2) Unit Selection Procedure. Three cases are considered in the logic flow for selecting a firing unit:

(a) Requests from infantry units with attached artillery. (Either companies with artillery attached directly or companies of battalions with attached artillery or student input from battalions with attached artillery.)





(b) Other requests directly to 105 batteries operating with a decentralized battalion FDC.

(c) Requests to battalion FDC. ((a) and (b) are combined in the flow by making the attached unit and unit assigned to reinforce the attached unit available-to-fire in case (a) and only units not attached available-to-fire in case (b) and (c).)

The search for a unit to fire is in the following sequence:

(a) If the mission is preplanned and the artillery unit assigned is in condition B, that unit is assigned as the firing unit. If not, units are searched in the sequence numbered below, depending upon case, until the first unit meets the conditions specified:

Unit/Condition	1	C a s e	
		2	3
Main Unit/ A	1	1	1
Unit Rein			
Main Unit/ A	2	2	NA
Main Unit/ B	3	3	3
Unit Rein			
Main Unit/ B	4	4	NA
Any Other			
Unit/ A	NA	5	2
Any Other			
Unit/ B	NA	6	4

- Notes:
- 1) Main Unit is the attached unit in Case 1 or the unit providing observers in Cases 2 and 3.
  - 2) When more than one unit is involved in a particular case, the sequence is from 105 units to 155, then 8 inch.
  - 3) Missions from Regimental FSCC have no main unit and enter at step 2, Case 3, then to step 4.



- 4) In Case 2, sequence 5 or 6 would occur when there is decentralized FDC and the called 105 battery cannot pass the mission directly to any other unit which could fire, but there is another unit which could fire. The mission is considered as passed to battalion then to the other firing unit and a ten-minute time delay penalty is added to the delivery time.

(b) If, at the completion of the sequence above no unit has been selected, the lowest priority mission for those units in Condition C is canceled if it has a priority lower than that of the new mission. The firing unit is then assigned the new mission. If there is no lower priority mission and the requesting unit has not been assigned priority of fires, the mission cannot be fired. If the requesting unit has been assigned priority of fires and there is a unit in Condition C firing for another infantry unit not assigned priority of fires, this mission is canceled and the new one assigned. If, at this point, no assignment has been made, the mission cannot be fired and the appropriate FSCCs are notified.

e. Mortar Shoot Routine (Figure 4)

The Mortar Shoot Routine is called when mortars are selected for a mission in the Weapon Selection Routine or Bn FSCC requests a mortar mission. If from the Weapon Selection Routine, a check is made to determine if the requesting unit has a mortar section attached. If so, that unit is assigned to fire. Otherwise, the mission is treated as a request to the battalion mortar platoon.



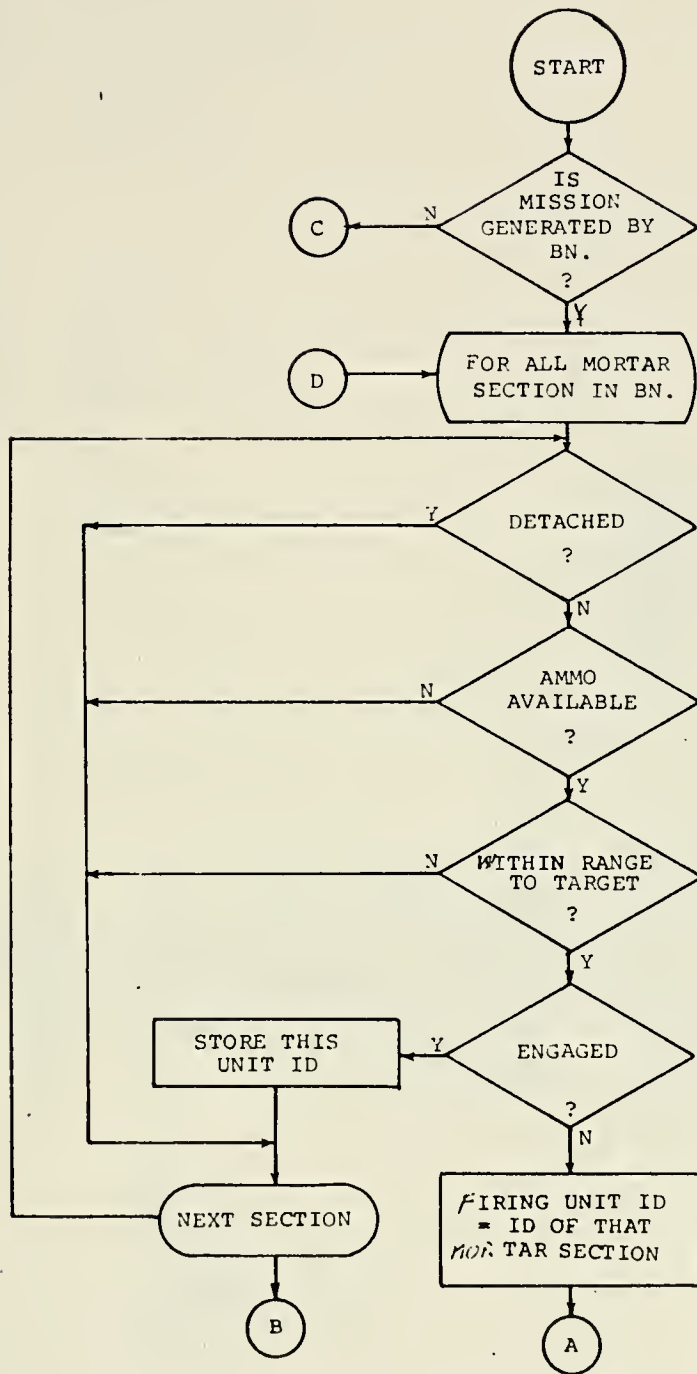


Figure 4 - Mortar Shoot Routine



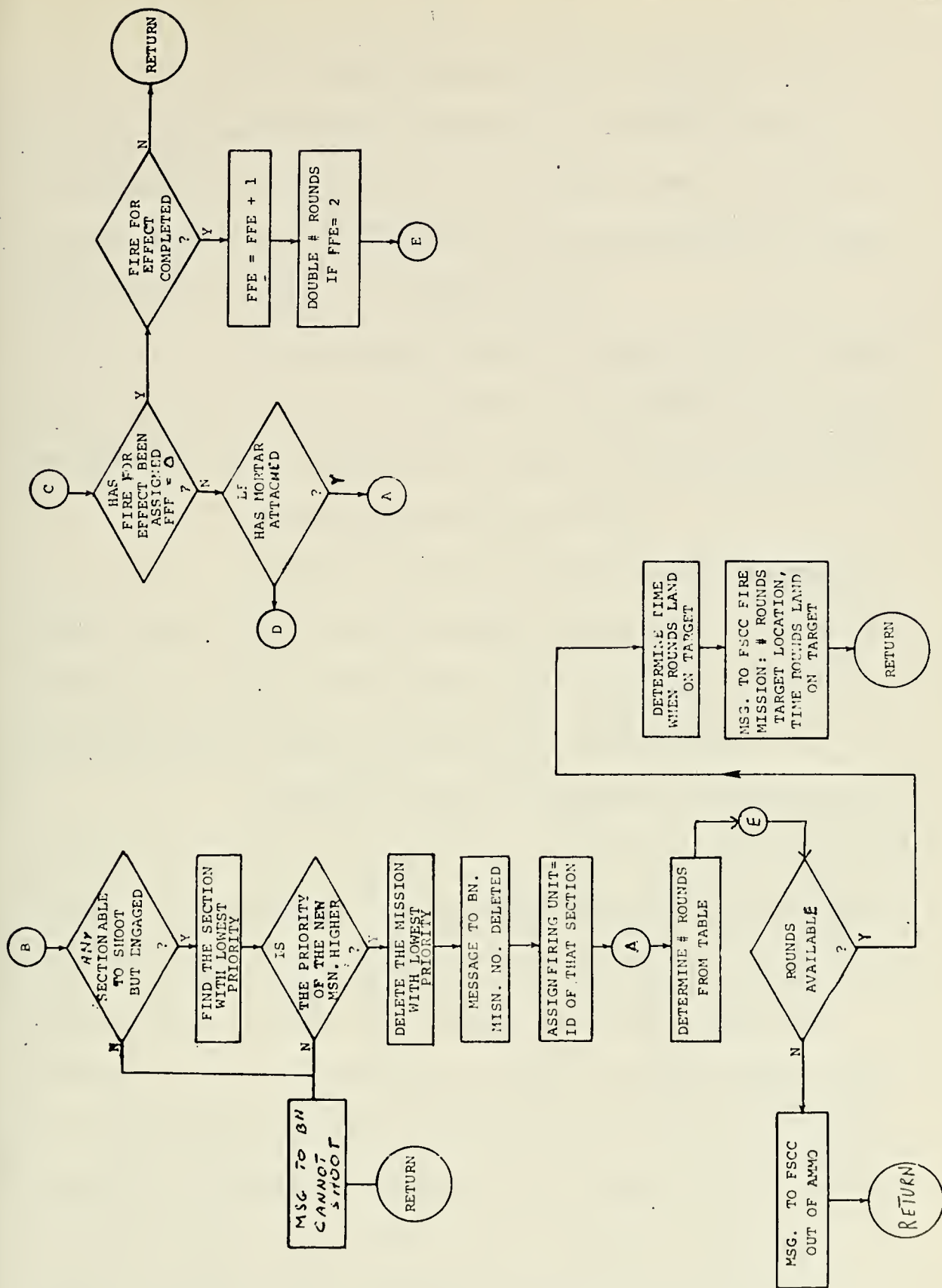


Figure 4 - Part 2





The number of rounds to be fired for the first FFE is a function of target type and is determined by table lookup (Figure 5). It is doubled for the second FFE, on the assumption that, if it must be repeated, the target is more important than originally assessed, and the observer would normally ask for additional fire.

Rounds on target includes the delay time. A 12-minute delay is included to allow for computations, time of flight, and operating the weapons. A three-minute delay is assumed for each subsequent FFE.

f. Artillery Shoot Routine (Figure 6)

Artillery Shoot Routine determines number of rounds to be fired, and rounds on target (time rounds land on target). It is called initially by the Artillery Unit Selection Routine and again by the Main Fire Support Routine when fire for effect (FFE) is completed.

For the first round in adjustment for missions not in support of close combat, and for FFE for not observed (student originated) missions, the impact point is calculated by using random normal distribution with mean at location reported by FO (determined and stored in the Weapon Selection Routine) and standard deviations of range and deflection errors of the weapon as a function of gun-to-target range. For computational simplicity, PER and PED are used as the standard deviations. Casualties are assessed if the adjusting rounds impacted within 200 meters of any LF unit, and a message is sent to the battalion stating number of casualties caused by friendly artillery



rounds. After the adjusting rounds, the aim point of the gun is assumed to be the actual target location. The number of rounds to be fired is obtained from the following table.

Target Type	81mm mortar	105mm	155mm	8 inch
a	48	24	24	8
b	48	36	24	8
c	40	48	36	12
d	32	72	60	24
e	48	72	60	20
f	32	72	48	12
g	48	48	36	12

Figure 5 - Rounds in Effect

The rounds on target is calculated by summing the current game-time, delay for the first FFE (8-11 min., depending on weapon type) and the time required to fire the adjusting rounds (2 or 3 minutes per round, depending on caliber).

If the LF is in close combat and had lost the battle, three FFEs are assigned concurrently to the primary firing unit and the reinforcing firing unit in order to allow the unit to withdraw.

For the second FFE, the number of rounds to be fired is doubled and remains constant for the subsequent FFEs. The aim point is assumed to be the actual target location, and the rounds on target



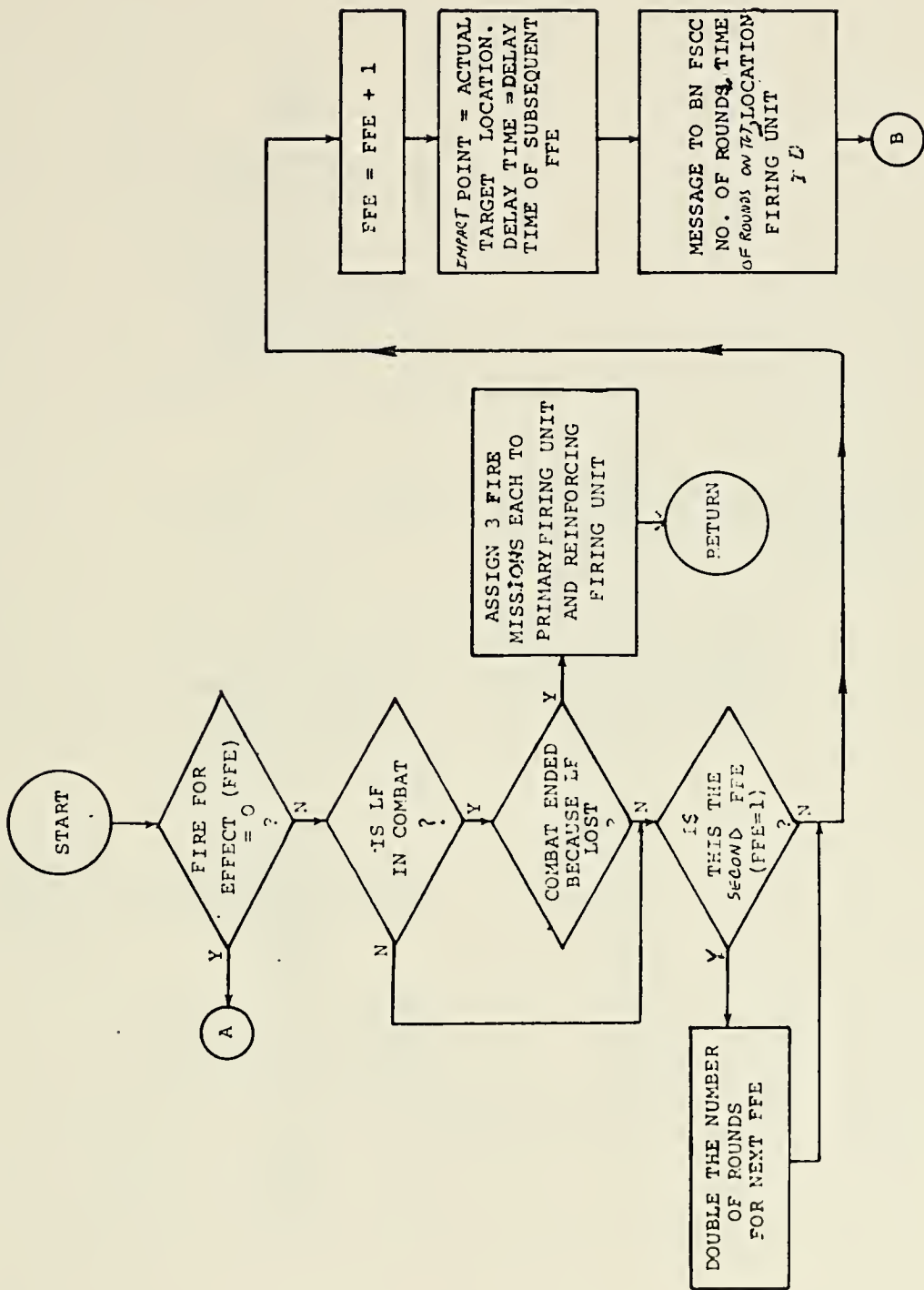


Figure 6 - Artillery Shoot Routine



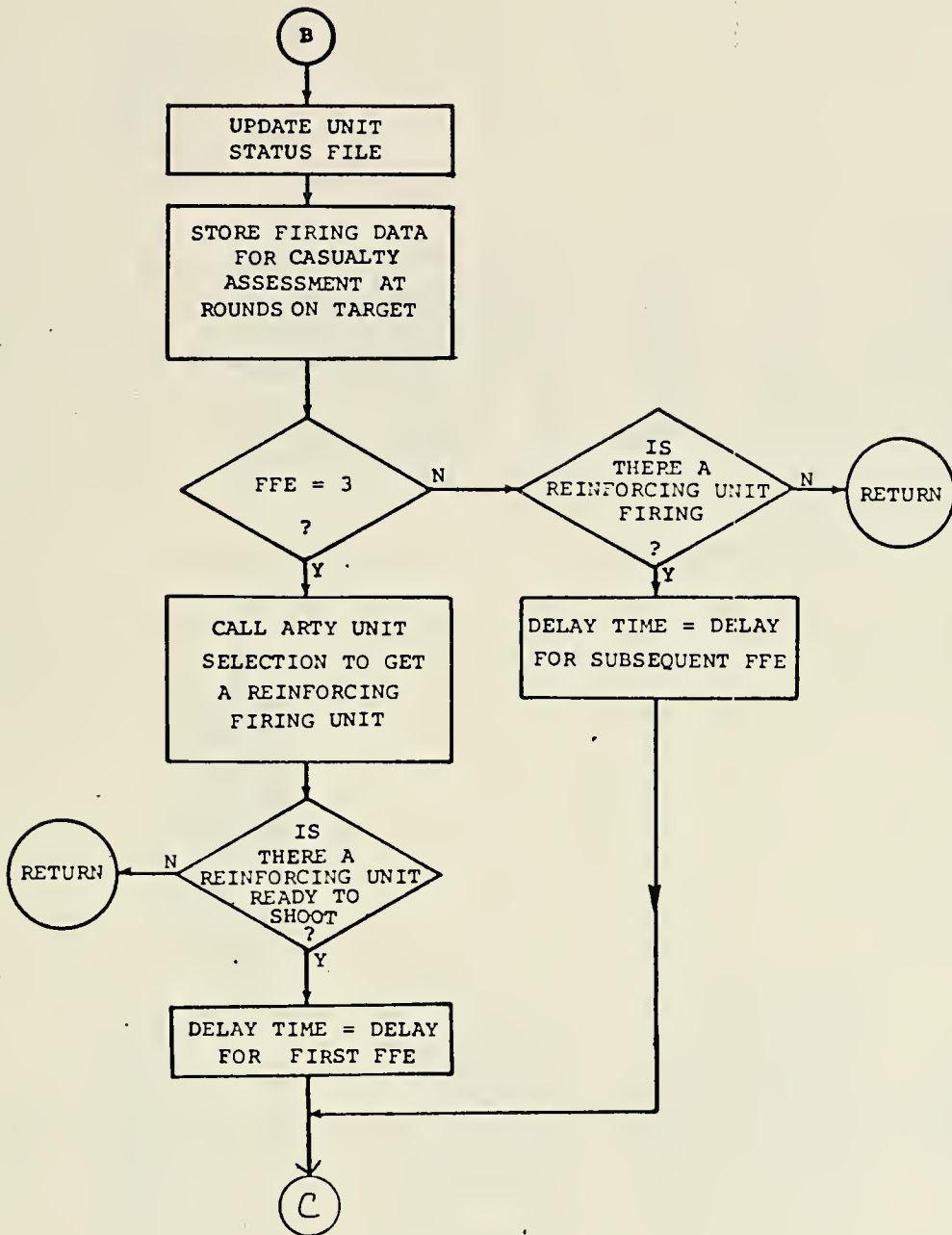


Figure 6 - Part 2





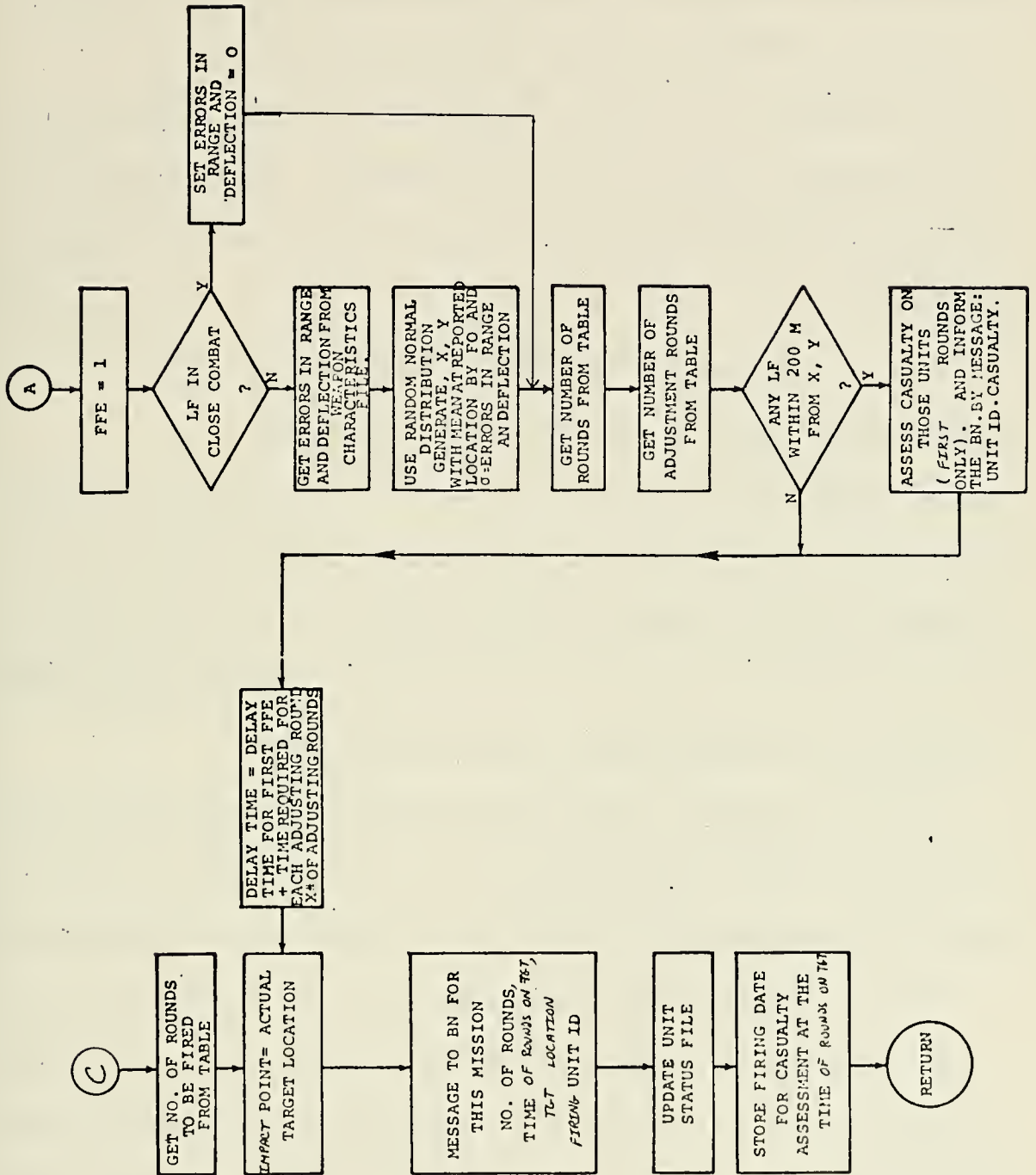


Figure 6 - Part 3



is taken as the current game-time plus the time delay for the FFEs (4 to 11 minutes per FFE, depending on caliber). This time includes observer preparation, transmission and time to fire approximately 1/2 the rounds.

When a fourth FFE has been requested, the Artillery Unit Selection Routine is called upon to select a reinforcing unit to fire on the same target. The number of rounds and rounds on target for the reinforcing unit are determined by the same method used for the primary units.

g. Naval Gunfire Shoot Routine (Figure 8)

Naval Gunfire Shoot Routine is called first when naval gunfire is selected for a specified fire mission by the Weapon Selection Routine and the mission is approved by the FSCC. At the completion of each FFE the routine is called again by the Main Fire Support Routine to initiate other FFEs.

For 0413 five ships are participating in the exercise. One direct support (DS) ship of types DD-718, -946, -945, -950 is assigned to each battalion, and one general support (GS) of type CLG-3 is assigned to the regiment. Each DS ship is responsible only for those missions generated by the battalion to which it is assigned. The GS ship is responsible for those missions generated by the regiment only. Each ship has two firing batteries except for DD-718, and -950 (which have one battery each). Six inch batteries may fire two missions simultaneously. Other calibers are limited to one. The number of guns and caliber of each battery are listed in the following table.



SHIP	GUN TYPE	NO. OF GUNS
CLG-3	6"/47	3
	5"/38	4
DD-718	5"/38	4
DD-945, -946	5"/54	3
	3"/50	4
DD-950	5"/54	3

Figure 7 - Naval Gunfire Ships

When a mission enters, it has already been assigned to a particular ship. Assignment to a battery is made based upon range, restrictive fire plans, and number of missions already in progress.

Missions generated internally are assumed from a naval gunfire spot team, and are considered adjusted. The number of rounds in adjustment is a function of observer-to-target range, and is a table look-up. The impact point of the first round(s) in adjustment is determined using the procedure outlined in IV.A.2.c.

The time of rounds on target is determined by using a delay time of 15 minutes for 5"/38 and 11 minutes for all others, plus a delay of 2 minutes per adjusting round. For subsequent FFEs, the delay assigned is three minutes independent of caliber.



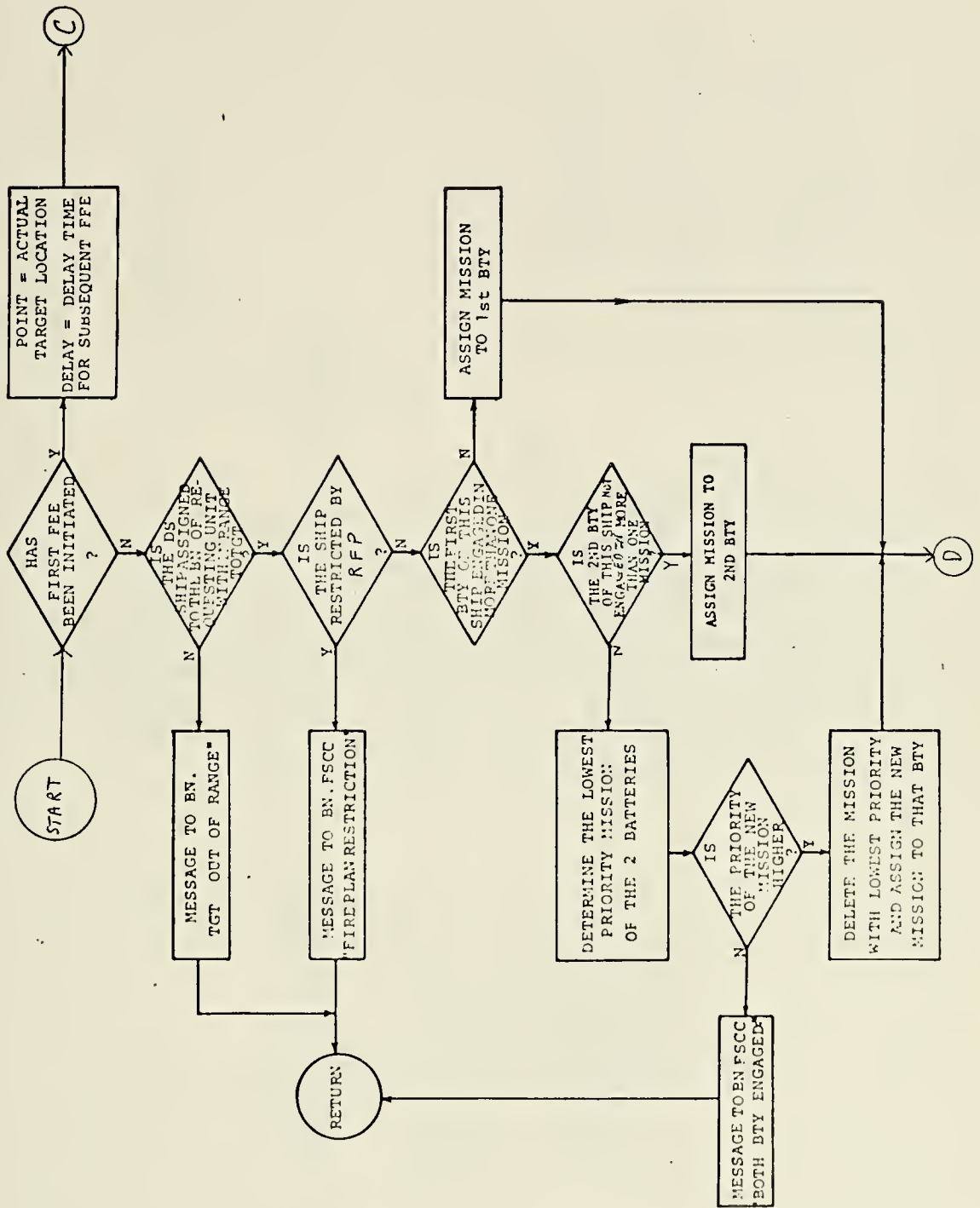


Figure 8 - Naval Gunfire Shoot Routine





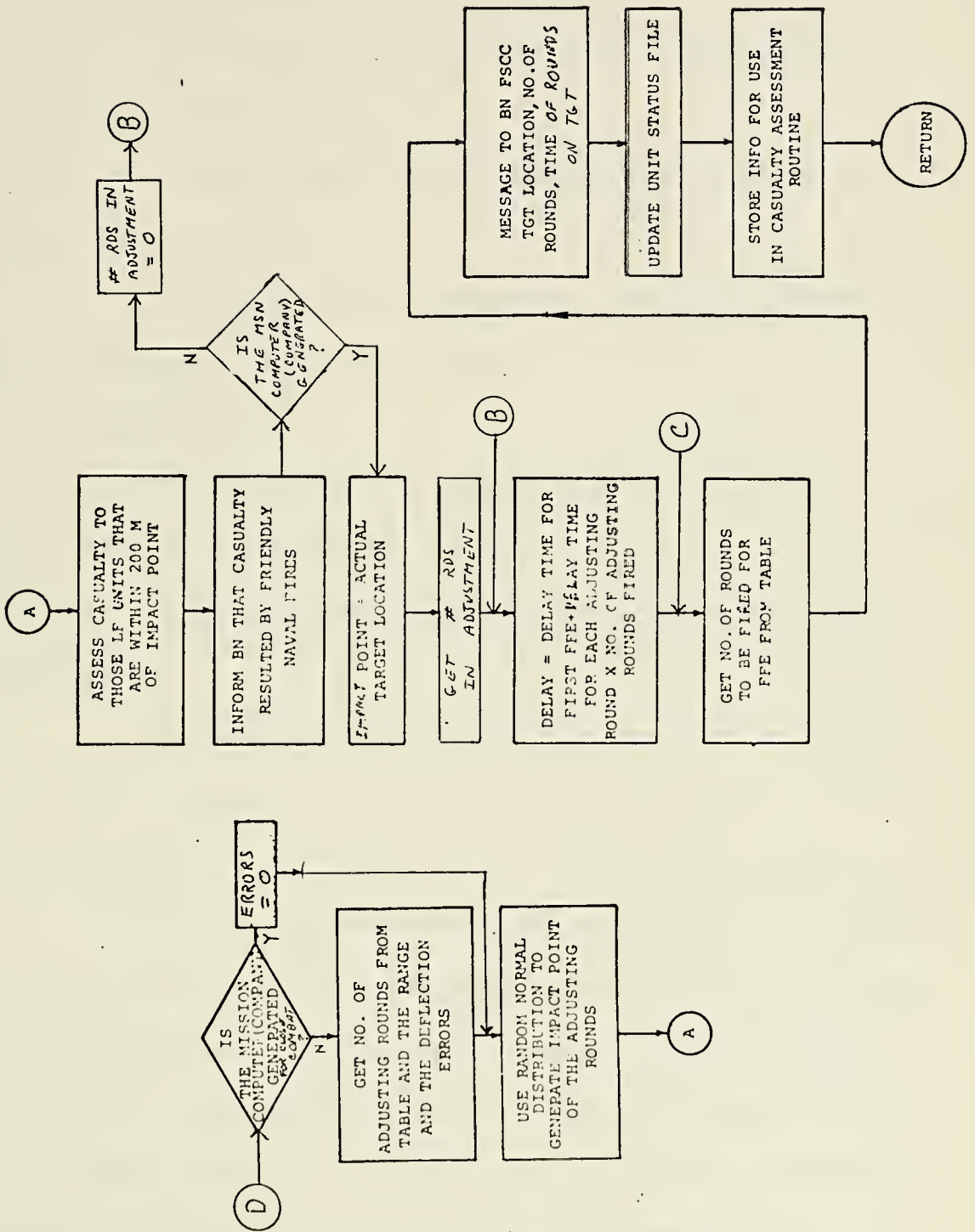


Figure 8 - Part 2



## B. AG SYSTEM (Figure 9)

### 1. Purpose

The AG Fire Support Routine is designed to:

- a. Automatically initiate fire missions against LF units in close combat with an AG unit.
- b. Accept missions from the AG unit controller against any target.
- c. Provide the internal bookkeeping capability to insure reasonable response from the enemy artillery.

### 2. Assumptions

- a. All AG units have communications with each of the firing units, with no delay in time.
- b. Each AG artillery or mortar platoon may engage in one mission at a time.
- c. Preference is given to firing the shortest range weapon within range to the target.

### 3. Procedure

The enemy artillery units are listed in file in order of increasing range. The first unit that is not engaged and within range of the target is selected as the firing unit. The number of rounds for FFE is a table lookup for internally generated missions, and in the controller's input message for other missions. Time delays from the initiation of the mission are based upon caliber, and are table inputs. Once a unit has been



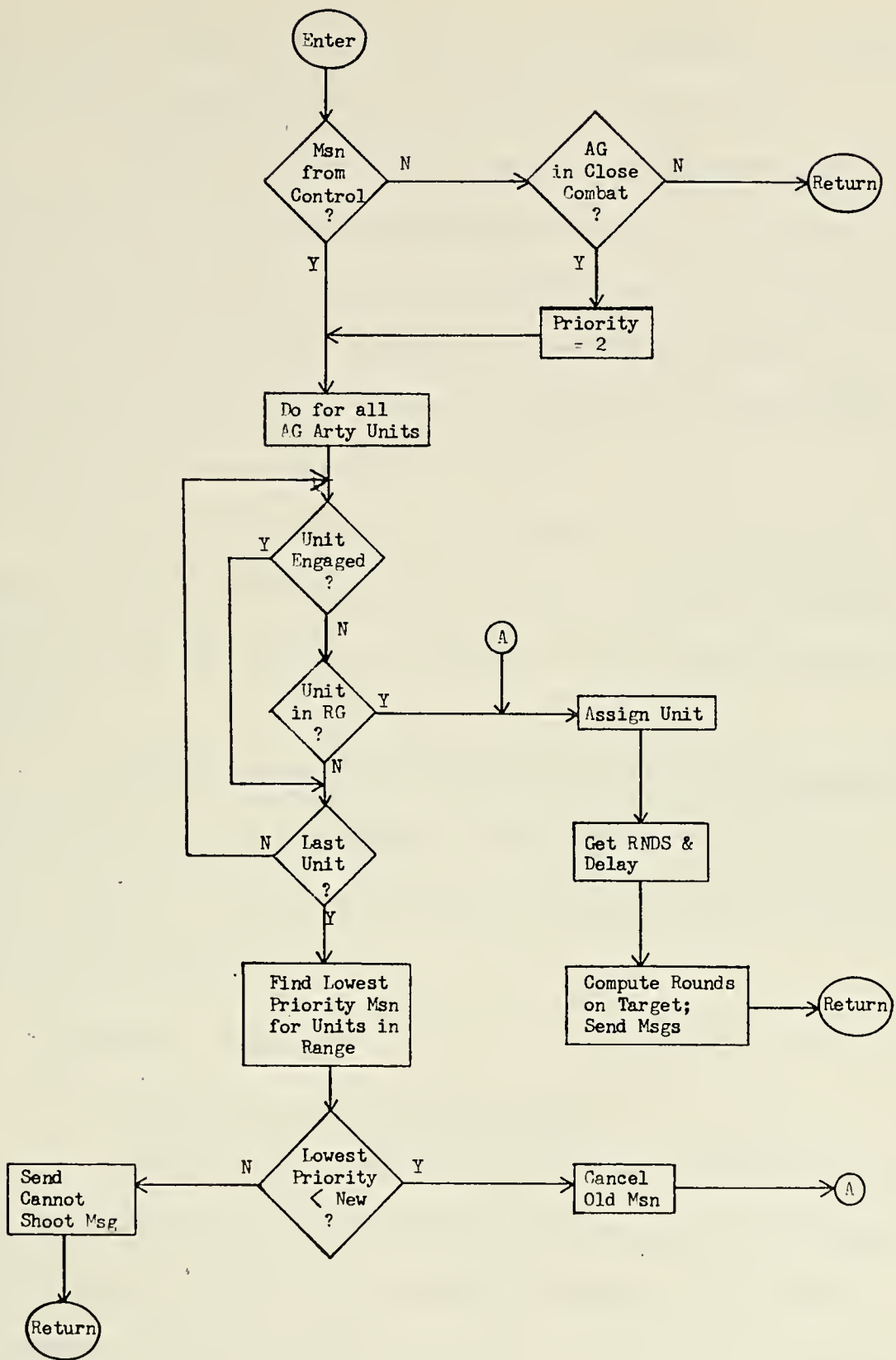


Figure 9 - AG Fire Support Routine



selected, the number of rounds, and times of FFE determined, a message is sent to the controller and to the Casualty Assessment Routine.

If there is no unit within range that is not engaged, the lowest priority mission of those within range is compared to the new mission. (All internally generated missions are assigned a priority of 2. This provides the controller with the capability of overriding any other mission by assigning a priority of 1.) If the new mission is of a higher priority, it is fired in lieu of the lower priority mission.

No errors are included in any mission. The impact point for missions generated within the machine logic is the actual LF unit location. The impact point for controller input missions is the location in the input message.

Missions input by the controllers will have one FFE delivered, and then the mission will be canceled. Other missions (in support of close combat) will continue in FFE until the controller cancels the mission or the contact is broken.

## C. SUBSIDIARY ROUTINES

### 1. Subroutine Restrictive Fire Plan (RFP)

Subroutine RFP is called from the Artillery Unit Selection and Naval Gunfire Shoot Routines to determine if any of the student imposed restrictive fire plans will prevent the unit from firing. An approximate computation is made to determine if the line of fire would pass through the altitudes assigned to the RFP at the centerline, and if so, that fact, and the RFP number would be returned to the calling routine.





With the number of charges that may be fired at a given range, and the number of different projectiles possible, it was not deemed economical to attempt an exact computation for the RFP. Instead, for artillery, a high and low charge were selected for a given range span, and the maximum ordinate for each used to provide a minimum trajectory and maximum trajectory which could be used to hit a target within the span. For naval gunfire, only one trajectory is used. For both weapons systems, it is assumed that the maximum ordinate occurs at  $2/3$  range to the target.

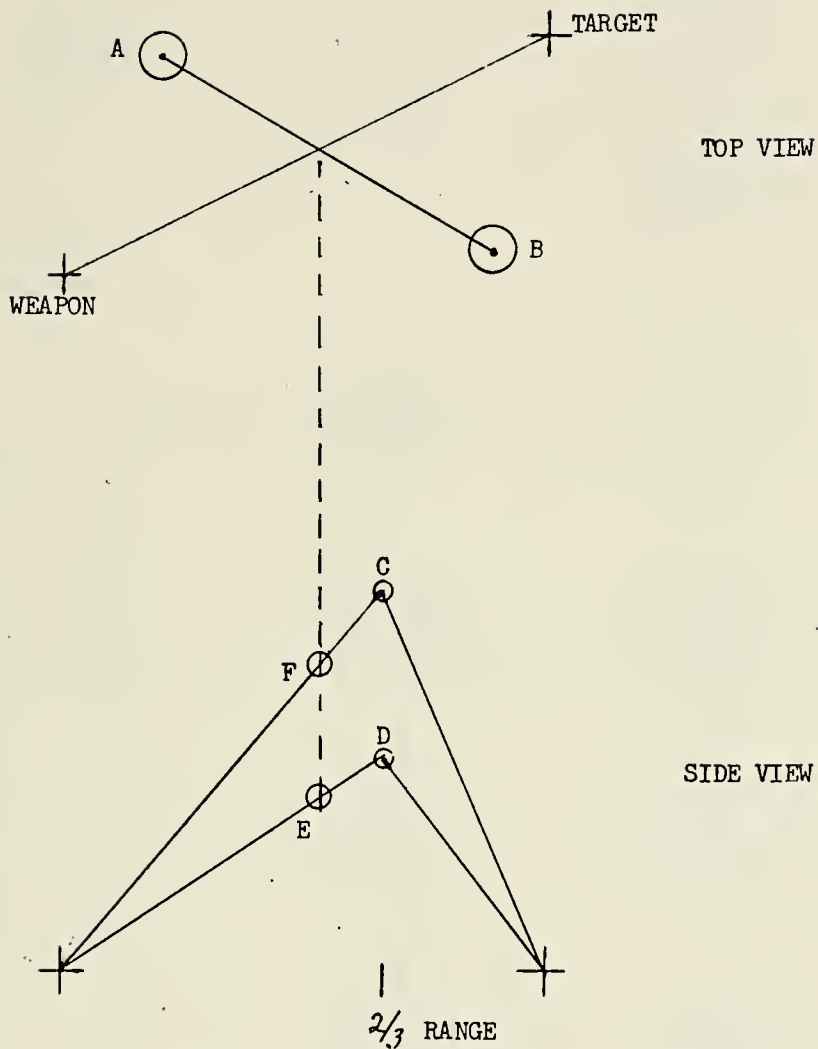
To determine if the weapon is restricted, first the gun-target line is projected onto a 0 altitude surface. (See Figure 10.) If it does not intersect the RFP centerline, the weapon is not restricted.

If the gun-target line does intersect, a check is made to determine if the weapon can fire over or under the RFP, using the maximum ordinates determined above. If one of the trajectories clears the RFP altitudes at the centerline, the weapon is assumed able to fire. If not, the weapon is assumed restricted and unable to fire.

## 2. Artillery On Call Unit Assignment Routine (Figure 11)

Within the play of 0413, students at the FSCC level will be allowed to input on-call targets which may later be used for firing on targets of opportunity, resulting in a reduction of the normal time delay. Although input to the on-call list normally begins at the company level, no attempt was made to generate this input to the FSCC.





- A, B = ENDPPOINT COORDINATES OF RFP CENTERLINE
- C, D = . MAXIMUM-MAXIMUM AND MINIMUM-MAXIMUM ORDINATES FOR THE WEAPON
- E, F = INTERSECTION OF TRAJECTORIES WITH VERTICAL PLANE OF RFP

If the minimum altitude of the RFP is above E and/or the maximum altitude is below F, the mission can be fired.

Figure 10 - Subroutine RFP (Diagram)



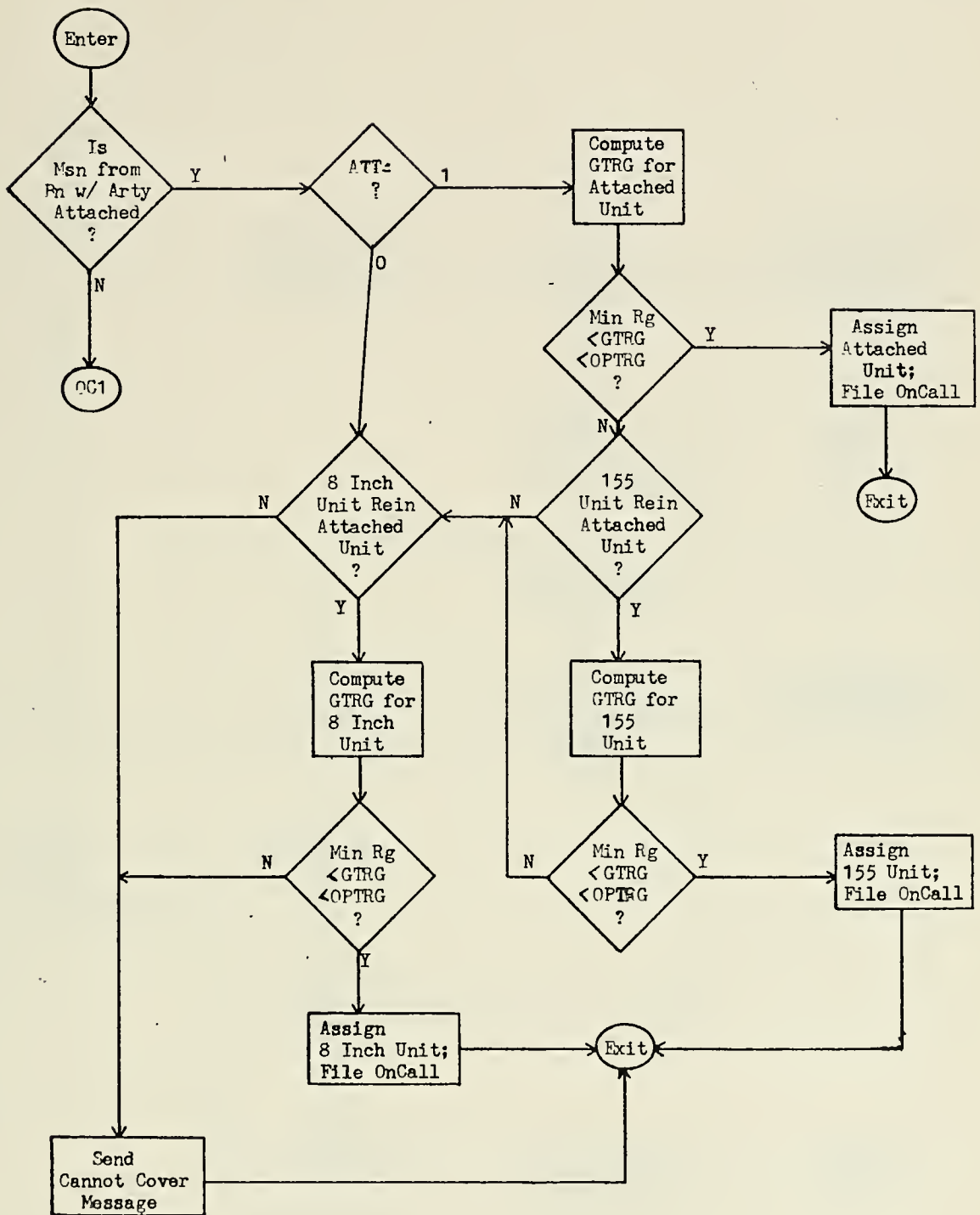


Figure 11 - Artillery On Call Unit Assignment Routine



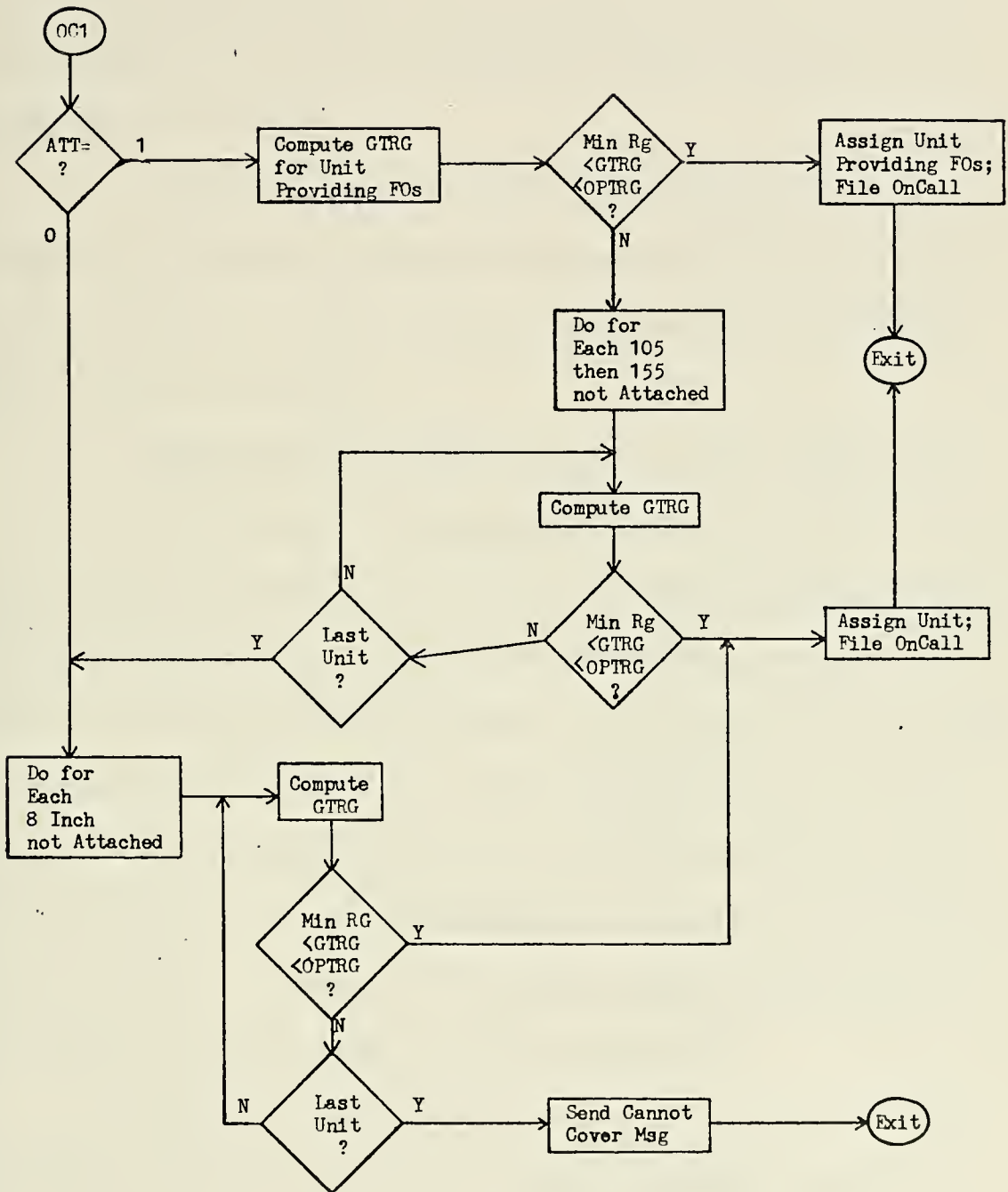


Figure 11 - Part 2





To activate the routine, the student inputs the target grid, artillery target type (to indicate if any artillery or only 8-inch can engage the target) and the unit being supported. The routine generates a unit to assign to the target and outputs the mission number, grid, and unit to which assigned. If no unit can be assigned for various reasons, the student will be so advised.

On-calls in support of infantry with attached artillery will be processed only through the attached unit and units assigned to reinforce the attached unit. For infantry without attached artillery, any artillery may be assigned to the target.

### 3. Artillery Schedule of Fires Processing Routine (Figure 12)

During operations intelligence will provide information on targets which are not observed at the time, but which may become a threat to the LF at a future time. To attack these a schedule of fires may be prepared. The supported infantry prepares a list of targets, the time span during which they will be attacked, and the weapon system to be utilized. Since this use of already limited resources will affect future availability, the logic includes a provision for scheduling fires. Time considerations, however, precluded simulating the scheduling of fires for all weapons, and for 0413 the effort was limited to the artillery logic.

The routine will be activated upon student input of a list of targets to be scheduled. Input will include: (1) artillery target type; (2) grid; (3) time to start; (4) time to end; (5) number of rounds. The routine will assign a mission number and a unit to fire, or the student will be advised if no unit can fire at the time required.



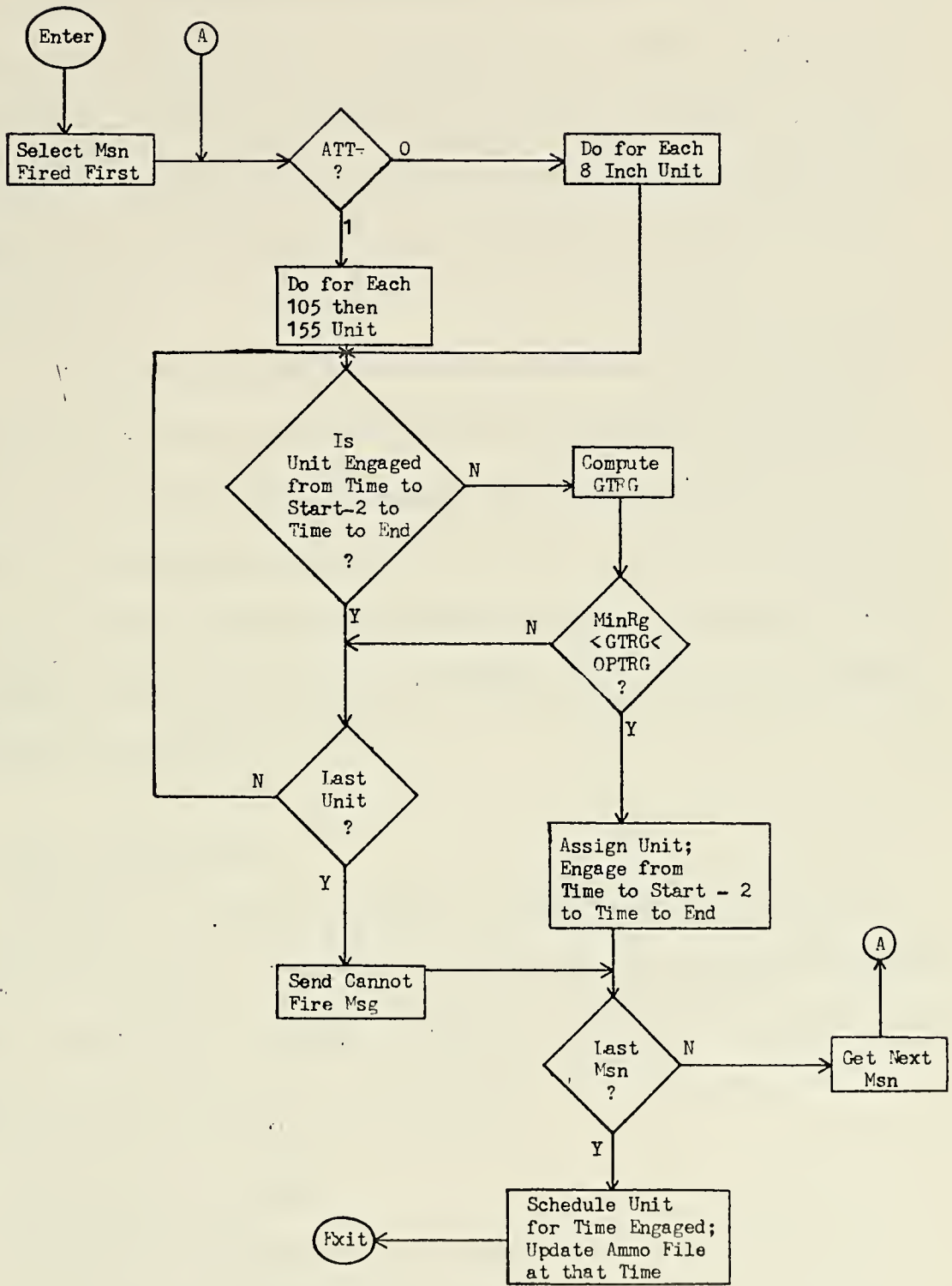


Figure 12 - Artillery Schedule of Fires Processing Routine



The artillery target type will indicate if the mission is for 8 inch only. If not, the mission is processed only for 105/155, and if none of these units are able to fire, no attempt will be made to schedule 8 inch. Assignment will be made to the first unit which is not engaged and has a suitable gun-to-target range. The unit will be considered engaged on the scheduled fire mission from the time to start minus two minutes, until the time to end.

If a unit is given a scheduled mission and at the time this mission is to be fired it is already fully engaged with non-scheduled targets, it is assumed that it is capable of temporarily handling the extra mission. If, on the other hand, the unit is fully engaged with scheduled fires when a target of opportunity appears, there is no automatic override. The target of opportunity will not be assigned unless one of the missions being fired is canceled.

#### D. INPUT PARAMETERS

Appendix C contains a sample set of input parameters for the fire support systems logic, and some of the inputs for the casualty assessment routine. While these numbers are expected to provide "reasonable" results, further research must be done in this area.

#### E. INSTRUCTOR'S GUIDE

Appendix D discusses the fire support systems logic from the instructor's view, and delineates some of the limitations in the present logic flow.



## V. FIRE SUPPORT SYSTEM LOGIC (IMPLEMENTATION)

Due to a number of factors, the logic outlined in IV could not be implemented in its entirety for the January 1973 run on 0413. Although implementation was beyond the scope of this paper, the changes made will affect future work made as an extension of the logic in IV.

### A. MAJOR DELETIONS

Deleted entirely from the fire support logic for 0413 were one major routine, one subsidiary routine, and one major concept:

#### 1. Artillery Unit Selection

It was decided to place students in the role of the artillery fire direction center, and they would make the selection of a unit to fire.

#### 2. Artillery Schedule of Fires

It was felt that the purposes of this routine could be satisfactorily met by requiring the student to input scheduled fires either at the time desired as a normal mission, or as an artillery preplanned.

#### 3. Observer and Ballistic Error

The impact point of all rounds was assumed at the target location or requested grid, as appropriate.

### B. MODIFICATIONS

#### 1. AG Fire Support System

Priorities were deleted, and if a unit cannot be selected, the routine is recalled after a delay (five minutes). When the AG





unit is in close combat, the mission terminates after three FFEs.

(See Figure 13.)

## 2. LF Missions for Units not in Contact

When a unit detects an AG force, but is not in close combat, only one FFE is delivered even if the units are closing. When the unit enters close combat, additional fires are requested.



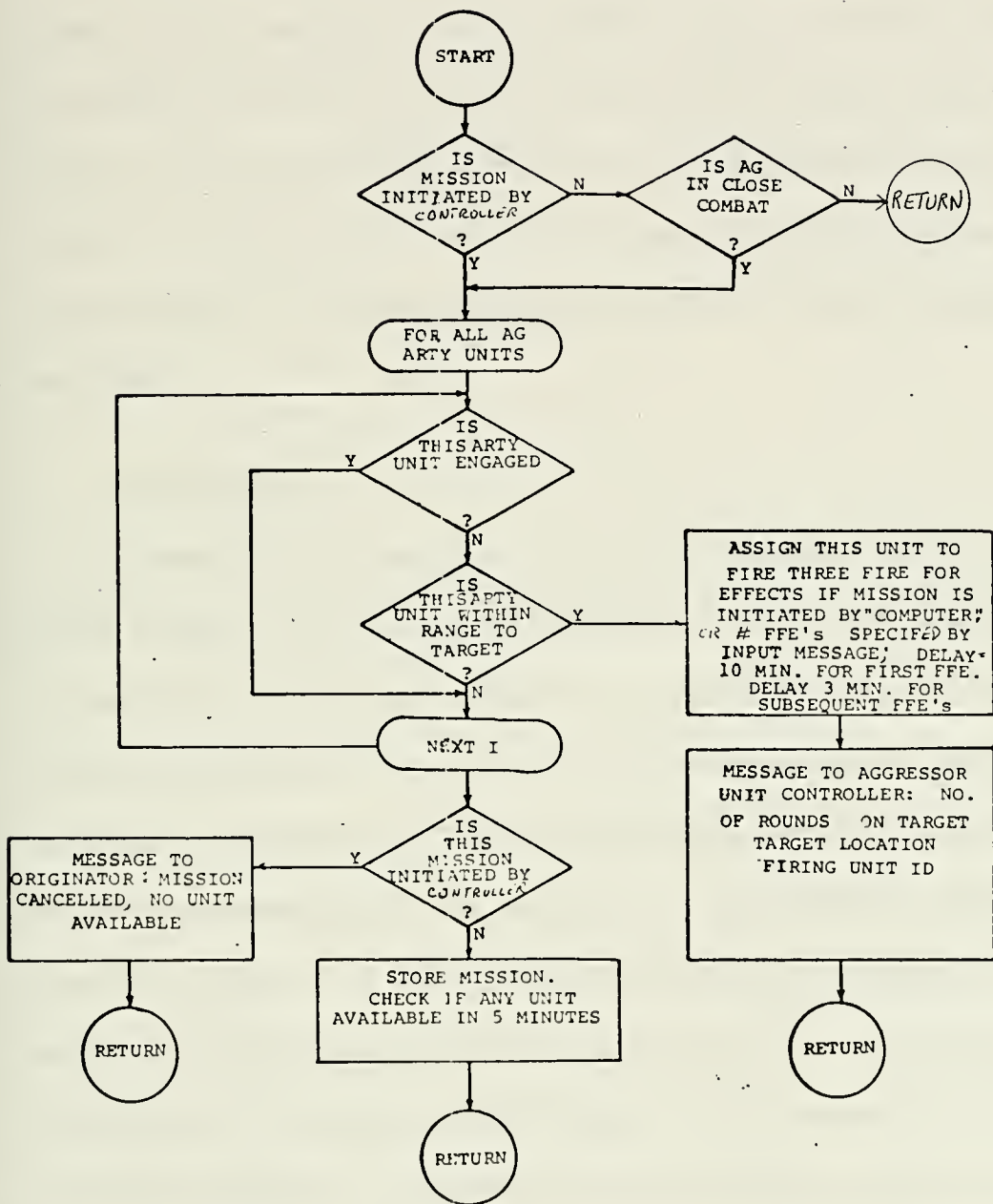


Figure 13 - Modified AG Fire Support Routine



## VI. FUTURE REQUIREMENTS

### A. 0413 CONCLUSIONS

Hardware difficulties precluded integrating the model with the January 1973 presentation of 0413 at AWS. A demonstration was given the students after the class, and indications were that it would be well received. There were some comments about the numbers of rounds assigned to mission, in particular for mortars, and these numbers were to be reviewed. The model was rescheduled for the class presentation in June 1973.

### B. PARAMETERS

A great deal of research is required on the input parameters. The delays assigned for the various situations could be critical to the outcome of a particular engagement. Analysis is required to determine if the rounds impacting on target should be distributed over time, or if the procedure of treating the FFE as an instantaneous event is sufficient. The coverage areas need to be analyzed in context with the Casualty Assessment Routine. A determination is required on whether PED and PER can be averaged for weapons that have more than one charge available, as was done, or should the logic include a charge selection. The sensitivity of availability of support to maximum ordinates should be measured to determine if the number of intervals can be reduced. In general, all the input parameters must be validated.



## C. ADDITIONS

### 1. Air Support

An Air Support Routine is needed to:

- a. Accept the request for support
- b. Assign assets to the mission
- c. "Fly" the aircraft to the target
- d. Monitor the RFPs
- e. Deliver the ordnance.

The practice of requiring students to perform these functions would not be acceptable in the wider usage.

### 2. Schedules of Fires/On-Calls

The players should be able to prepare schedules of fires for all weapons systems. Also, the logic in this paper does not provide for the production of company level input into the pre-planned target lists. In practice, this is where most of the on-calls will originate. The coordination/consolidation of these missions is a major function of the FSCC, and this input is important for a full play of the system.

### 3. Coordination Measures

Many of the coordination measures employed during actual combat will affect the timeliness and degree of support. Provisions should be made to include coordination measures such as the no-fire-line and boundaries.





#### 4. Munition Types

The capability to use illumination and white phosphorous ammunition, and others, in addition to high explosive, would insure more realistic play of the logistical systems, as well and adding to the fidelity of the combat.

### D. IMPROVEMENTS

#### 1. Weapon Selection

The logic must be validated in the Weapon Selection Routine, and provisions made for more varied target types to include moving targets.

#### 2. Artillery Unit Selection

Provisions should be made to allow a unit to fire on the move when appropriate, and to check the gun-to-target line when firing close to friendly units. The logic within the routine must be validated.

#### 3. Mortar Shoot Routine

The mortar shoot logic must be modified to treat the platoon as a unit when firing from a centralized position.

#### 4. Naval Gunfire

The logic in this paper treated the ship as fixed in location. The effect of ship movement should be studied. Also, since the range error is comparatively large, the "observer" must consider the gun-to-target line when selecting the weapon and firing.

#### 5. Observer Availability

The observer has been treated as always available when assigned to a unit, when he may actually be with another element



when support is required. Provisions should be built in to consider observer location and casualties.

#### 6. AG Fire Support

The AG systems within this paper provides the minimal outline required to place the system on line. Future models should more closely approximate the actual functioning of the enemy capability. As present logic limits what the players can do with LF support to that which is reasonable, similar safeguards should be built into the AG system.

#### E. FUTURE PROGRAMS

Within the 1970 to 1980 time frame, the structure of the supporting arms systems will be undergoing major modifications and improvements. Under development are systems which will automate many of the decisions now manually processed. Logic is being developed to recommend numbers of rounds to fire in effect on various targets. Informations systems are being improved to eliminate the delays passing information by voice. As these systems are integrated into the force structure the concepts and logic must be integrated into TESE logic.



APPENDIX A - SUPPORTING ARMS COMMUNICATIONS FLOW

<u>FLOW SEGMENT</u>	<u>BRANCH POINT INPUTS</u>	<u>PAGE</u>
COMPANY/PLATOON INPUT (NOT OBSERVER) -----	G, F, -----	75
OBSERVER INPUT -----	E -----	76
FSCC WEAPON SELECTION -----	J -----	76
BATTALION S-3 SEQUENCE -----	H -----	77
ARTILLERY UNIT MISSION INPUT -----	-----	77
FSCC APPROVAL SEQUENCE -----	I, M, N, S -----	78
MORTAR SEQUENCE -----	D -----	78
PRE-PLAN SEQUENCE (BATTALION/REGIMENT) ---	K, L, W, X -----	79
PRE-PLAN SEQUENCE (DIVISION) -----	Y -----	80
ARTILLERY SEQUENCE -----	B, T, V -----	81
NAVAL GUNFIRE SEQUENCE (DIRECT SUPPORT)---	C -----	82
NAVAL GUNFIRE SEQUENCE (GENERAL SUPPORT)--	P, R, -----	82
AIR SEQUENCE -----	A, A1, Z -----	83

BRANCH POINT IDENTIFICATION

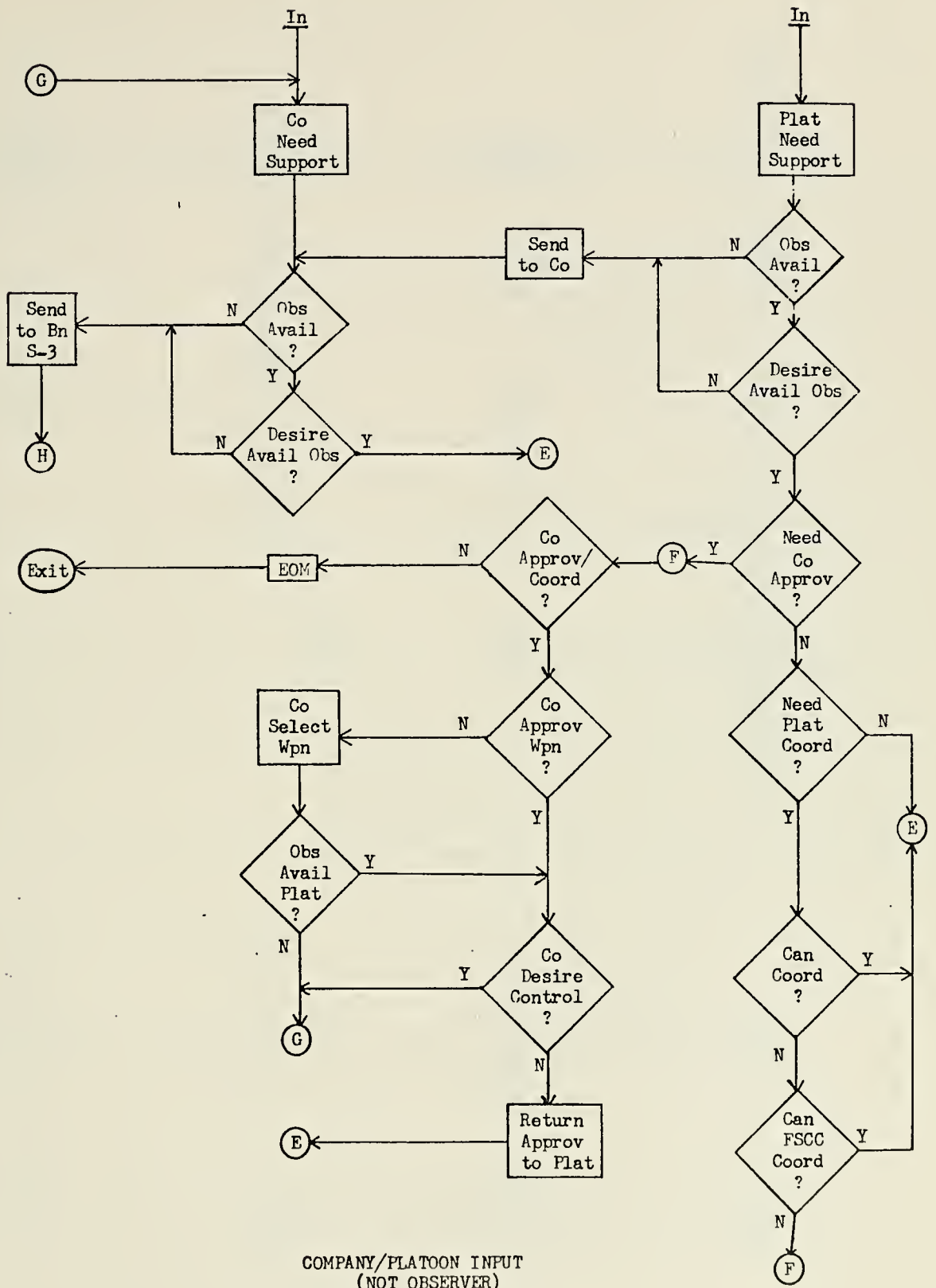
- A - MISSION ENTRY TO AIR SEQUENCE
- B - MISSION ENTRY TO ARTILLERY SEQUENCE
- C - MISSION ENTRY TO NAVAL GUNFIRE SEQUENCE (DIRECT SUPPORT)
- D - MISSION ENTRY TO MORTAR SEQUENCE
- E - MISSION ENTRY TO PLATOON/COMPANY WEAPON SELECTION
- F - MISSION ENTRY TO COMPANY FOR APPROVAL/COORDINATION
- G - MISSION ENTRY TO COMPANY FOR TRANSMITTAL



- H - MISSION ENTRY TO BATTALION S-3
- I - MISSION ENTRY TO FSCC FROM BATTALION S-3
- J - MISSION ENTRY TO FSCC WEAPON SELECTION
- K - PRE-PLAN RETURNED FROM DIVISION TO REGIMENT DISAPPROVED
- L - PRE-PLAN RETURNED FROM DIVISION TO REGIMENT APPROVED
- M - MISSION ENTRY TO FSCC APPROVAL SEQUENCE
- N - MISSION RETURN TO FSCC FROM WEAPON SYSTEM UNABLE TO COVER
- P - MISSION ENTRY TO NAVAL GUNFIRE SEQUENCE (GENERAL SUPPORT)
- R - MISSION ENTRY TO NAVAL GUNFIRE SEQUENCE (GENERAL SUPPORT) FROM BATTALION FSCC
- S - MISSION ENTRY TO FSCC FOR G/S NAVAL GUNFIRE
- T - ARTILLERY MISSION ENTRY TO G/S ARTILLERY UNIT
- V - ARTILLERY MISSION ENTRY TO UNIT TO FIRE
- W - PRE-PLAN EXIT FOR END OF MISSION
- X - PRE-PLAN ENTRY TO UNIT ASSIGNMENT
- Y - PRE-PLAN ENTRY TO DIVISION FSCC FROM REGIMENT
- Z - AIR MISSION EXIT RETURN TO FSCC - UNABLE TO COVER
- A1 - AIR MISSION ENTRY FOR AIRCRAFT RUN

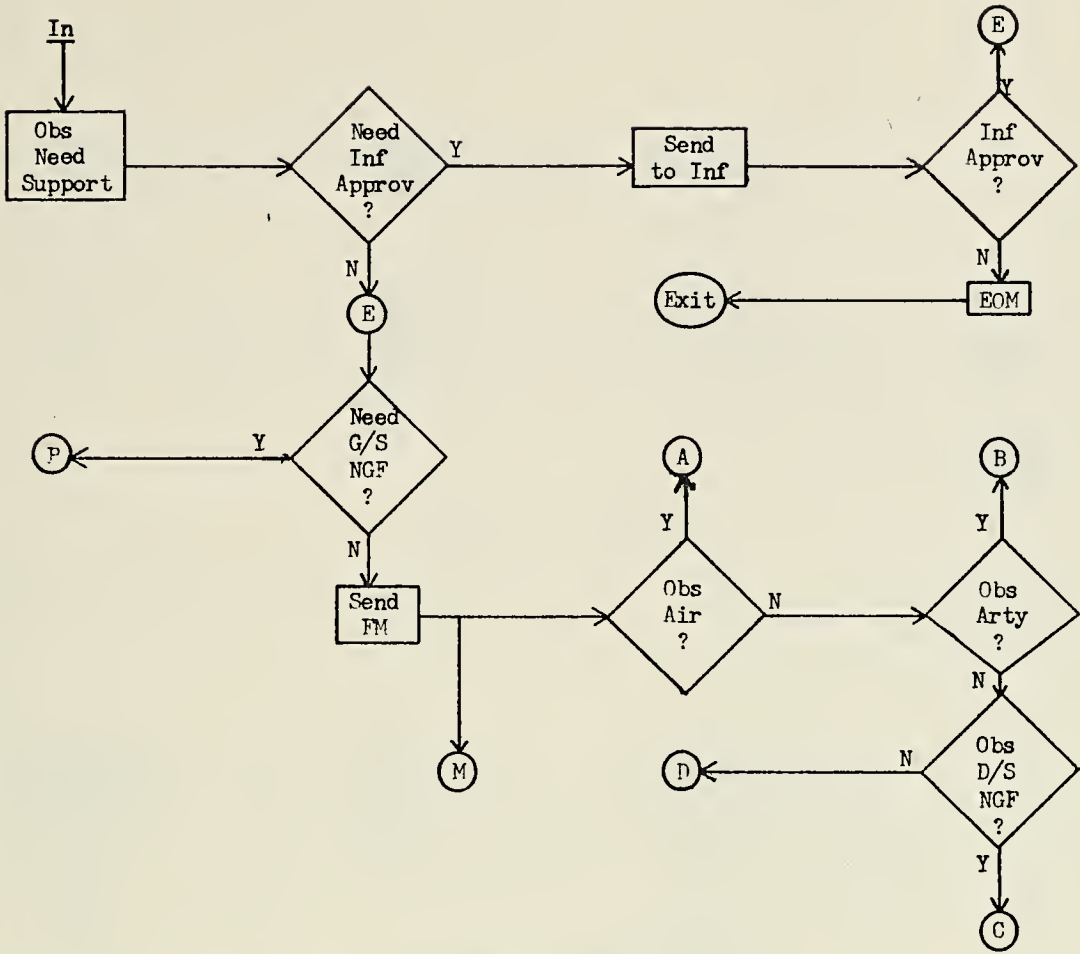




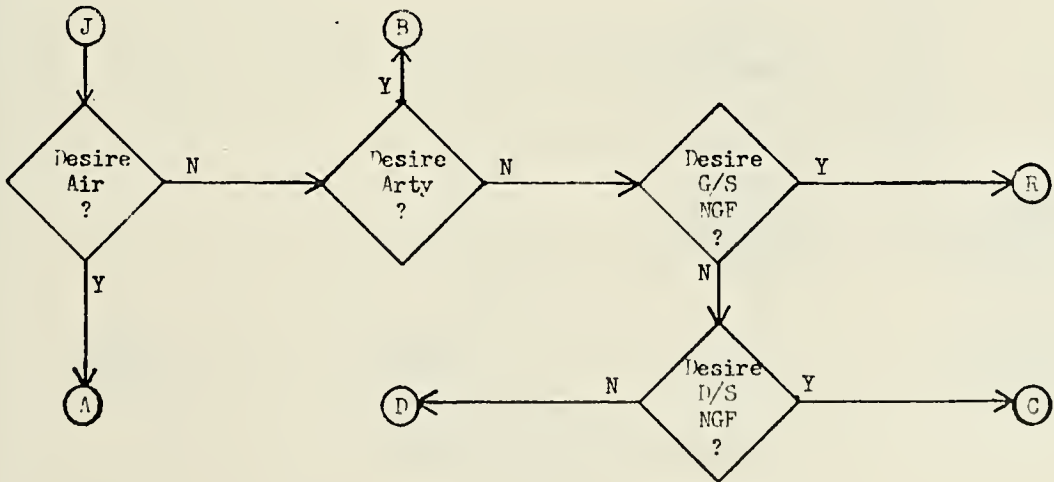


COMPANY/PLATOON INPUT  
(NOT OBSERVER)



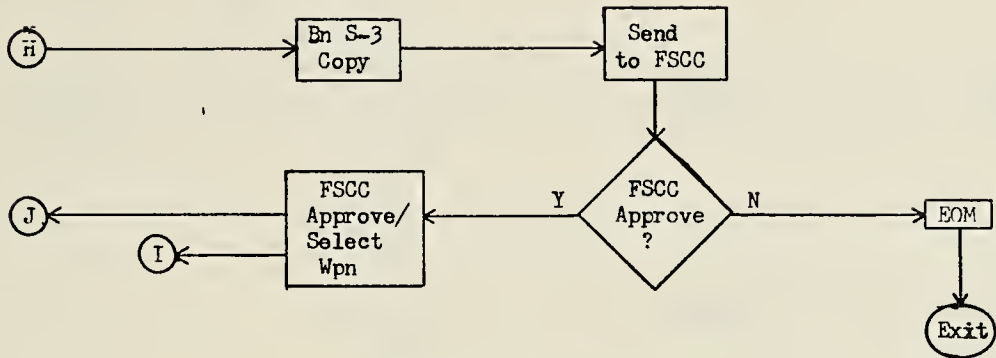


OBSERVER INPUT

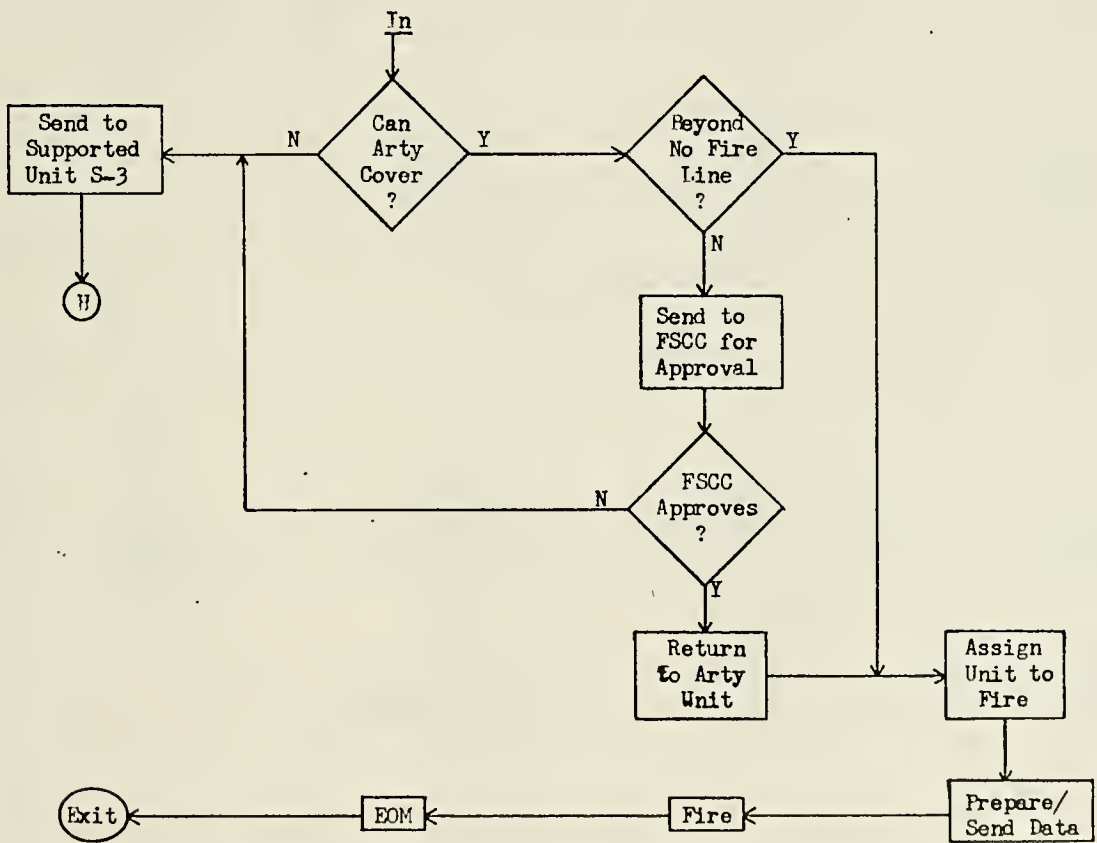


FSCC WEAPON SELECTION



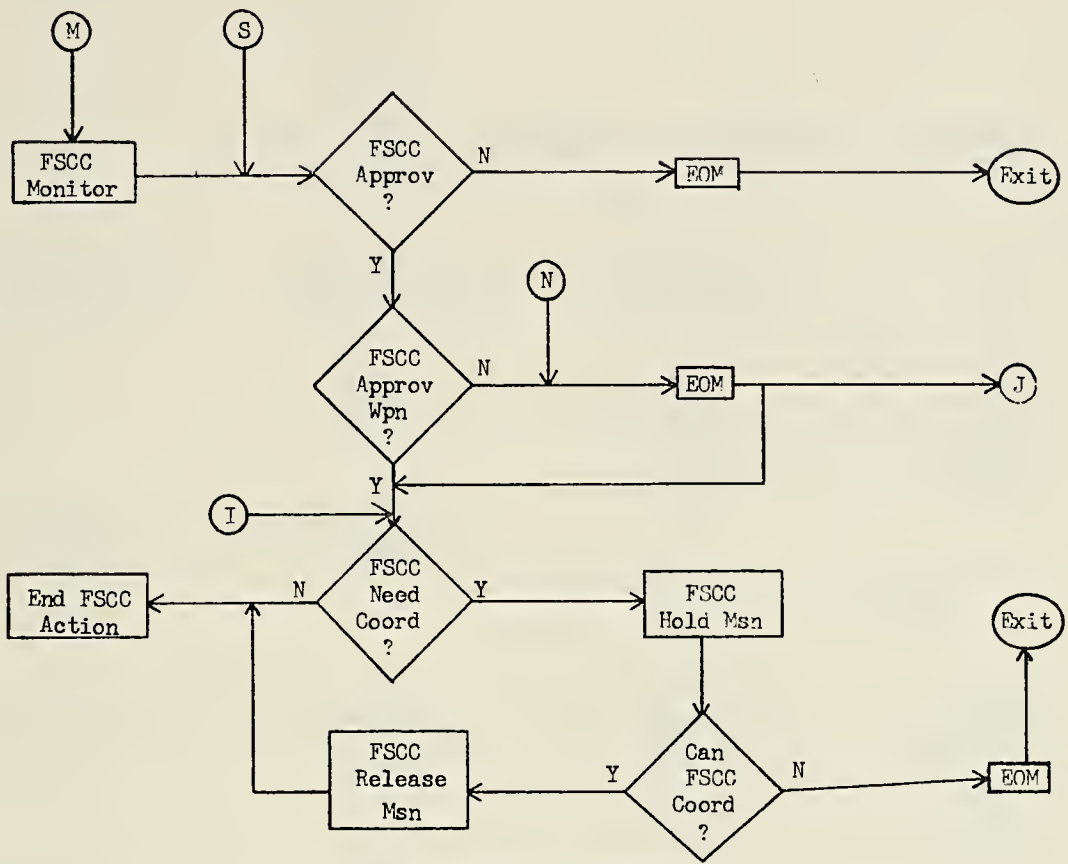


BATTALION S-3 SEQUENCE

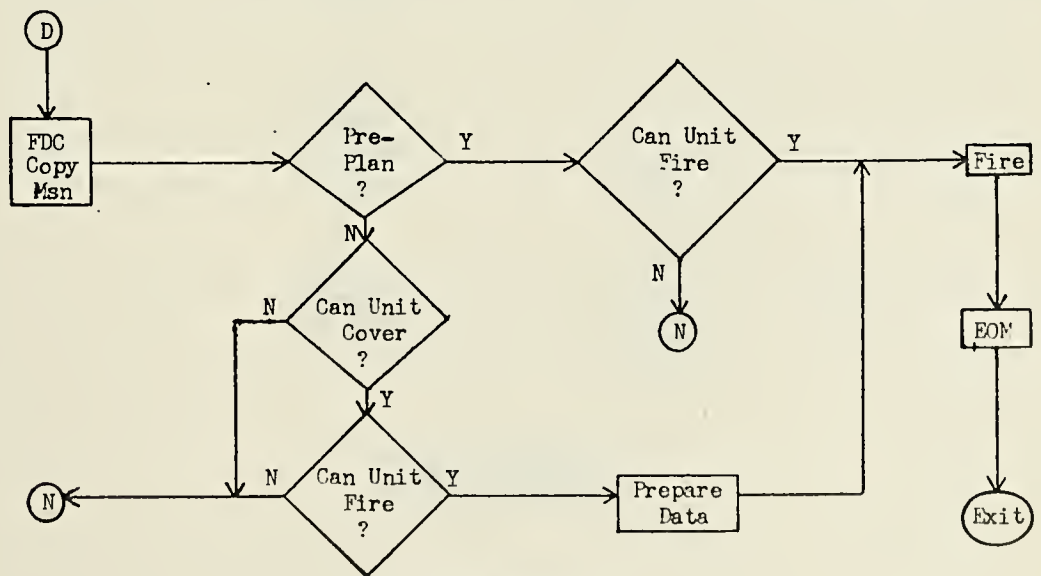


ARTILLERY UNIT MISSION INPUT





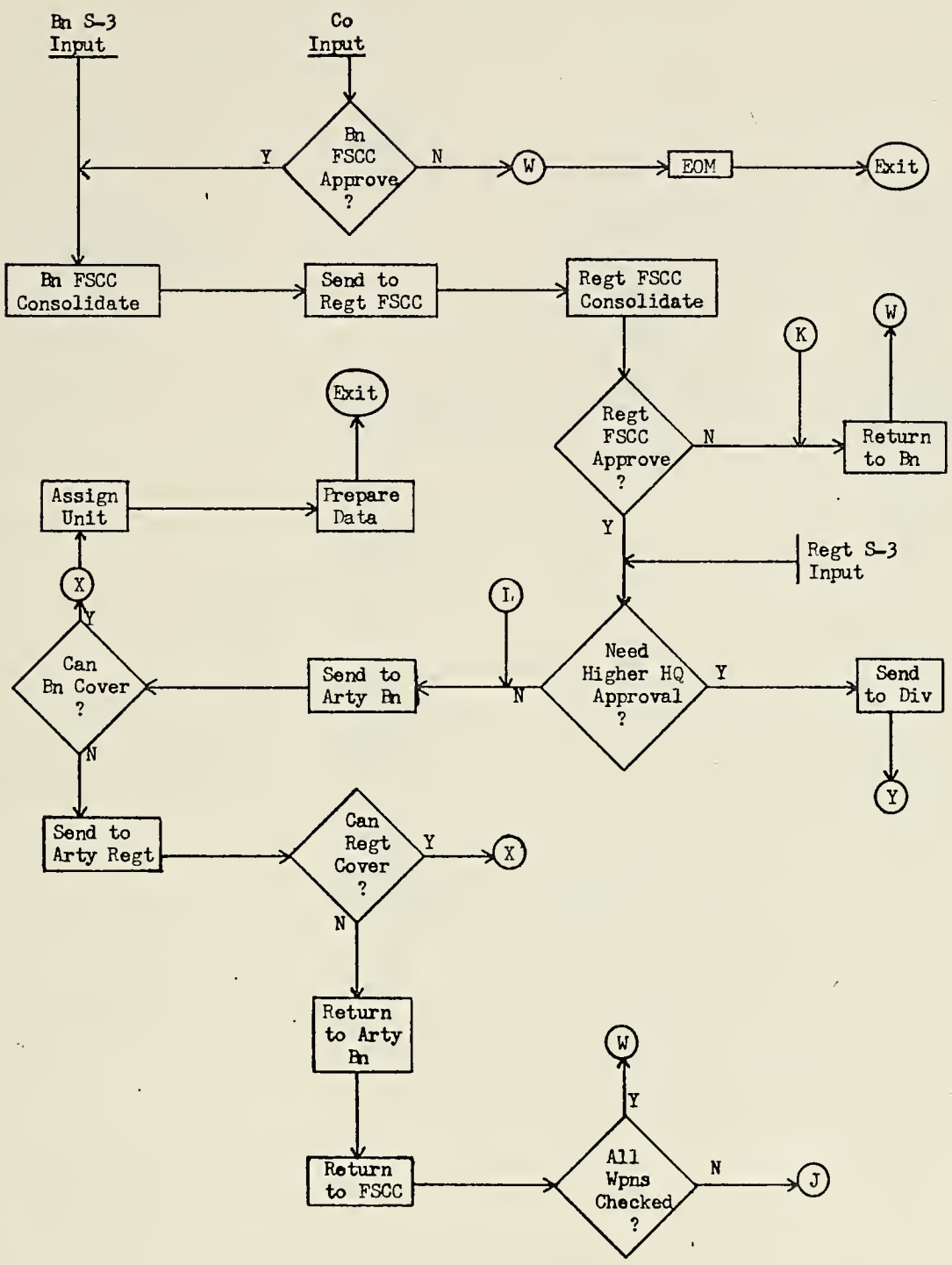
FSCC APPROVAL SEQUENCE



MORTAR SEQUENCE

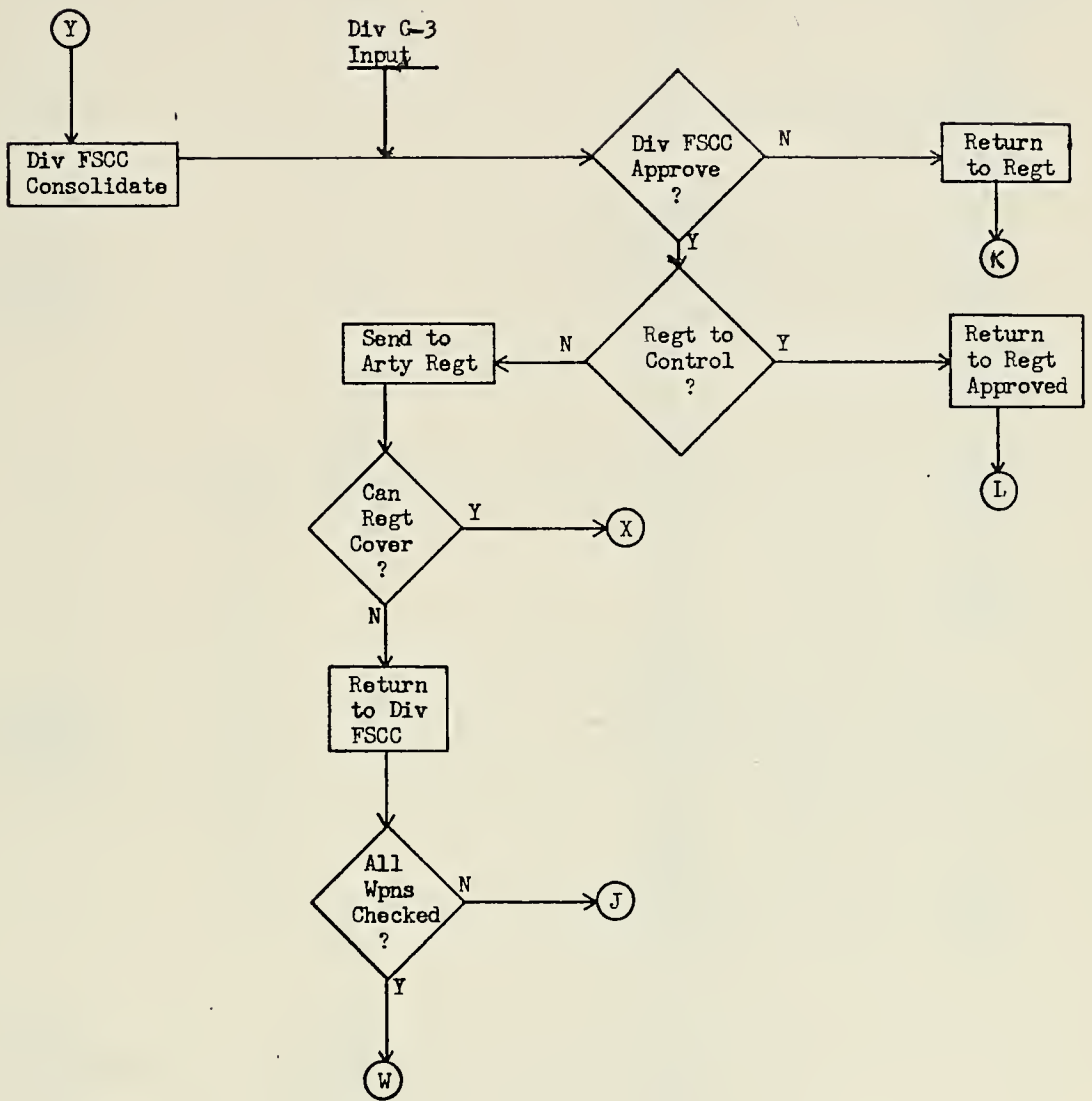






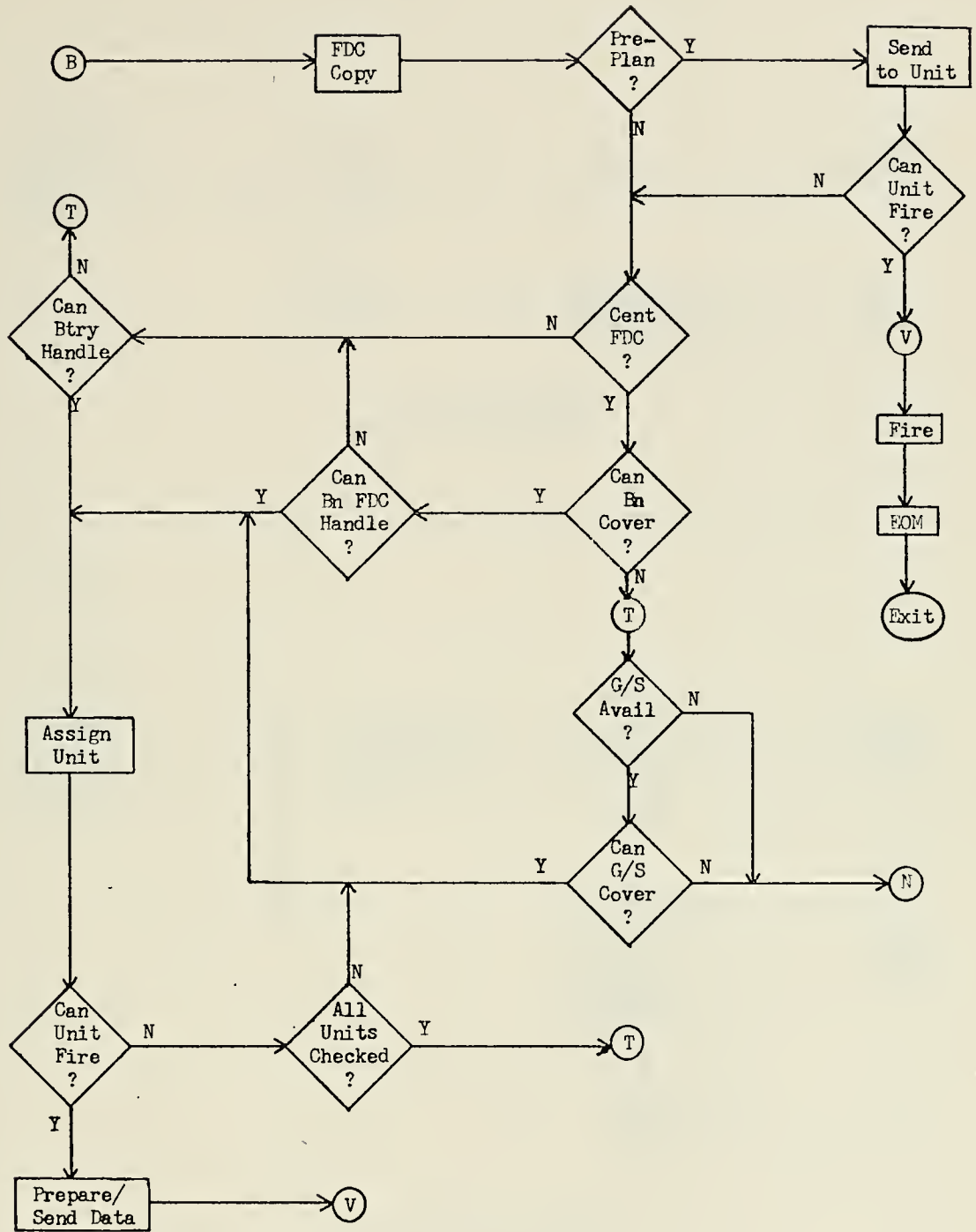
PRE-PLAN SEQUENCE  
(BATTALION/REGIMENT)





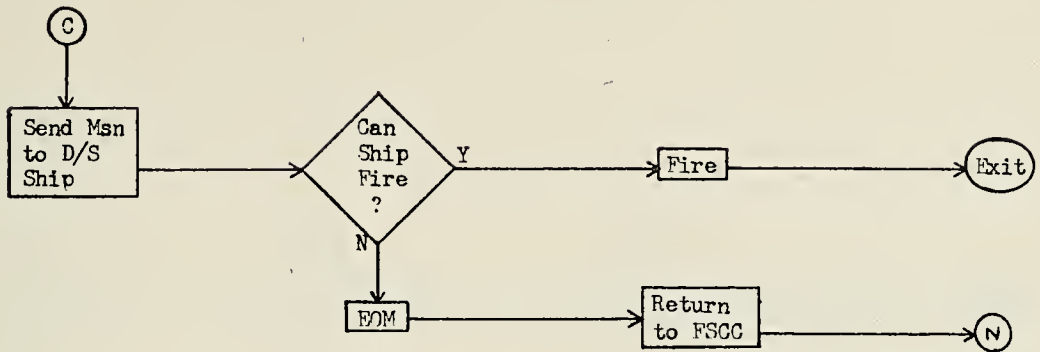
PRE-PLAN SEQUENCE  
(DIVISION)



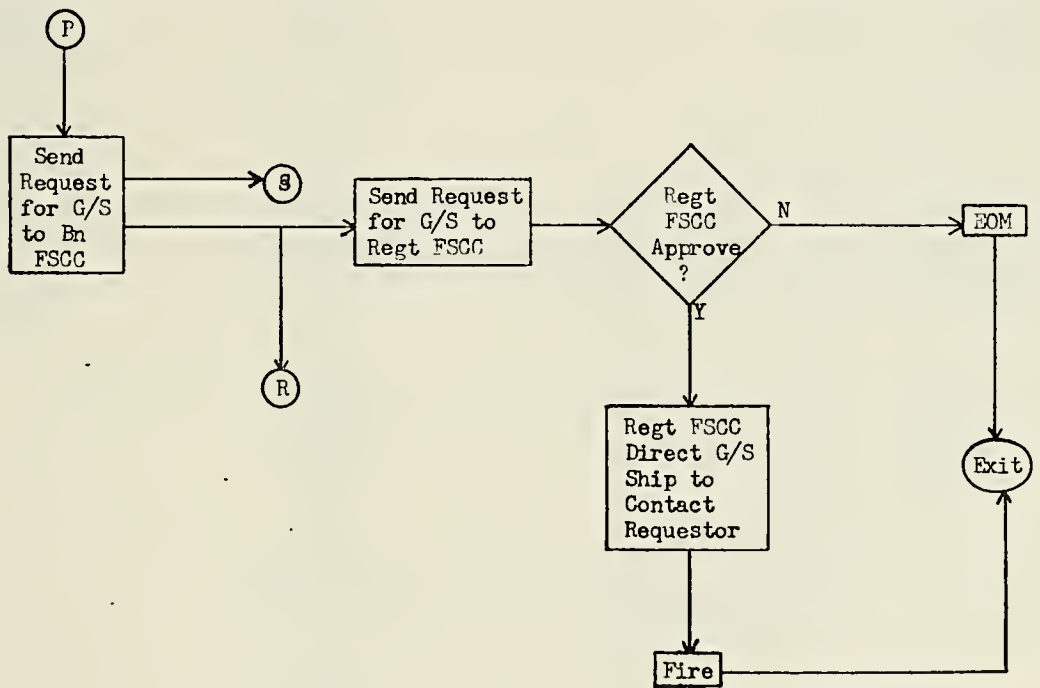


ARTILLERY SEQUENCE





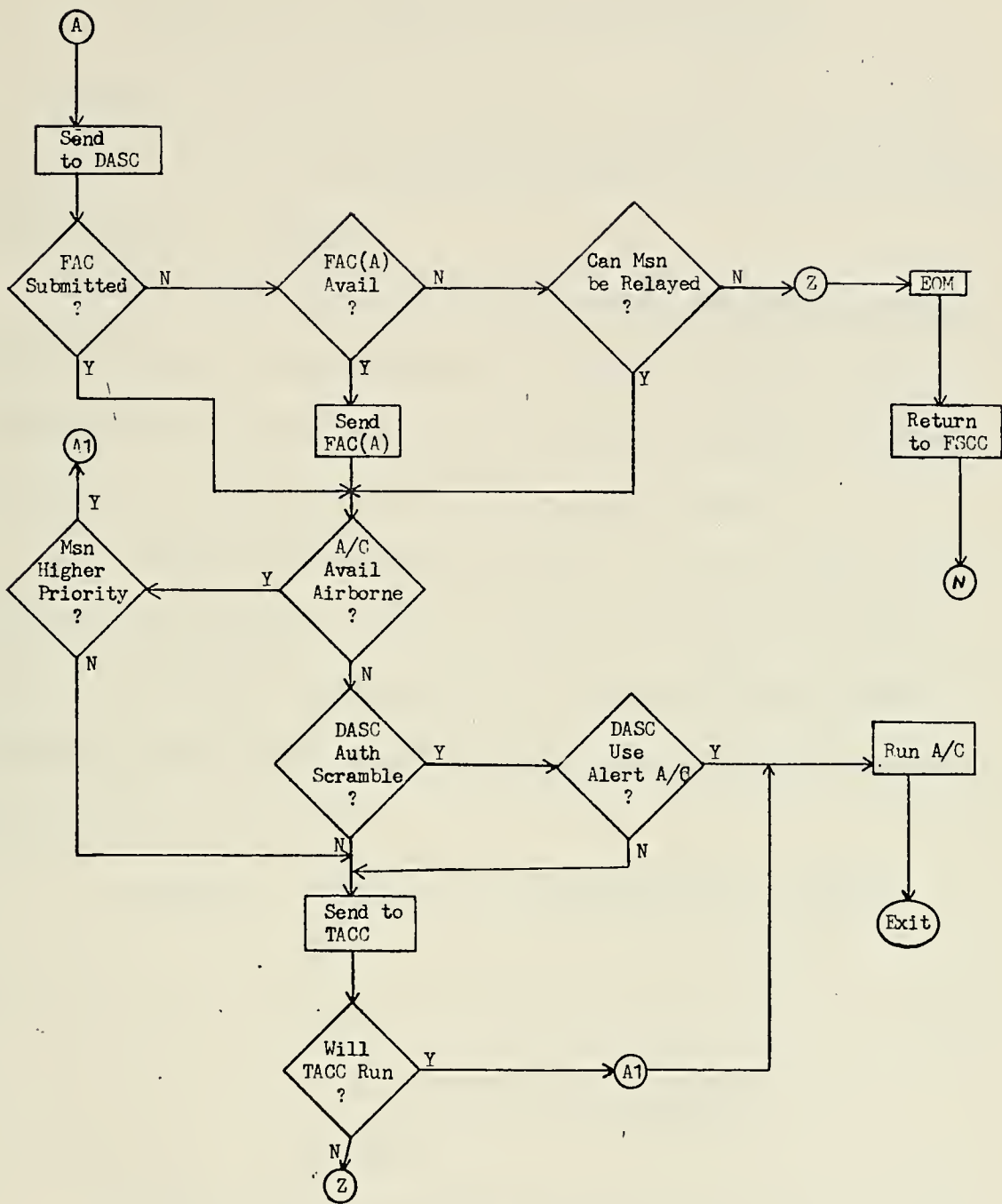
NAVAL GUNFIRE SEQUENCE  
(DIRECT SUPPORT)



NAVAL GUNFIRE SEQUENCE  
(GENERAL SUPPORT)







AIR SEQUENCE



## APPENDIX B - FIRE SUPPORT SYSTEMS PROPOSAL

In order to provide general guidance for planning 0413 with TESE in January 73, the following outline of intent for the fire support systems to be developed is submitted.

Initially, prior to the start of the execution, the supporting units will be identified by unit identification, mission, and type, and pre-planned targets to include schedules of fire will be entered. Units will be assigned to fire scheduled fires by the student players.

Artillery units - artillery batteries of 105's and 155's will be monitored by the computer. Eight-inch platoons (if required) will be monitored. The player will input the time of initial landing, and the machine will flag the unit as ready to fire at some preset time afterwards.

Each unit will be flagged with:

Mission - Normal (i.e., the DS Battalion in support)

GS

GS/R

Priorities of fires (if assigned)

Attached

105 Units will be flagged with the unit to which they are providing FO's.

Either centralized or decentralized FDC's can be handled.

One method will be indicated for each artillery unit.



Missions will be simulated at company level. Each target will be flagged with a priority (# yet undetermined) and a posture, which will indicate which weapons systems are capable of successfully attacking, e.g.:

1 = Mortars/artillery/NGF/air

2 = Artillery/NGF/air

3 = NGF/air

4 = Air

When a target is sighted, a weapon selection procedure, influenced by the type of observers available, will result in a mission transmitted to the supporting agency. The actual target location will be used, with the umpire having the capability of overriding and using another grid. (Prior to transmission, a search will be made of on-calls and scheduled fires to determine if the target is already scheduled or if there is an on-call near.)

A positive reaction from the Battalion FSCC will be required to allow the mission to proceed.

For air missions, the request will be submitted to DASC, and students will hand manipulate the process and input time and amount of ordnance delivered. Umpires will credit fire delivered and provide input to machine for assessment and update as appropriate.

For NGF, a request of DS support will be processed if within the maximum number of missions the ship can deliver. The time and standard amount of rounds will be computed.



For GS, NGF, a request will be submitted to the Bn FSCC and the mission processed when the Regt FSCC provides authorization.

For 81 mortars, those sections held at battalion level will be monitored. A maximum of two missions will be processed simultaneously. If the sections are not attached, but, in separate locations, each section will be allowed one mission.

For artillery, if centralized FDC is specified, the mission will be processed by artillery type required by the target (1=105/155/or 8", 2=155 or 8", 3=8" only), giving priority to the unit from which the FO is provided. Access to all GS will be simultaneous with the receipt of the mission.

For decentralized FDC or attached units, if the unit called cannot fire, a time penalty will be assessed before the mission can be processed through Bn for other units. If Rein units are assigned, they will be advanced first.

If the unit to which the observer is assigned has been assigned priority of fires, and the supporting unit is firing for another unit, the first mission will be canceled, if required to shoot, and a message submitted to the FSCC.

If the requested weapons system is committed to the fullest, either this information will be passed directly to the FSCC or, if a priority system can be established, the mission with the lowest priority target will be canceled, and this information passed to the FSCC.





Artillery mission capability will be:

1 mission per 8" platoon.

2 missions per 155 battery (two guns on 1 and 4 on the other)

2 missions per 105 battery (2/4)

Battalion FDC- 2 missions with ability to assign 1 to each battery under centralized tactical control, provided this does not exceed unit capabilities.

Ammunition for 81's, NGF, and artillery will be accounted for.

Ordnance for air will be student controlled.

A movement subroutine will determine time from receipt of movement order until unit arrives in location. The fire support routine will determine time from arrival until ready to fire for mortar and artillery units.

No coordination measures will be considered by the program. If a target is sighted, it will be "fired" upon. The umpire/FSCC will have to provide the override.

For artillery a first round location will be determined to include ballistic and observer target location error. This will allow umpires to penalize FSCC's for allowing missions too close to friendly units/without proper coordination. It may be included for NGF and mortars, if time permits.

Fire for effect missions will be plotted at this (above) location.

Observed and adjusted missions will be assumed on target for FFE.

Unobserved missions will be assumed at grid submitted + ballistic error.



The assessment routine will canvass friendly and enemy units, and provide assessment directly to the umpire. No attempt will be made at this time to determine what intelligence the FO might actually derive. This will have to be provided by the umpire.



APPENDIX C - SAMPLE INPUT PARAMETERS

	PAGE
Discussion of Methodology -----	90
155 Range Data Table -----	92
105 Range Data Table -----	93
8 inch Range Data Table -----	94
Mortar/Artillery Weapon Range Capability Table -----	95
Naval Gunfire Weapon Max Ord Data Table -----	96
Miscellaneous Data Table -----	101
Observer Adjusting Rounds/Error Table -----	103

(All ranges/errors are in meters.)



## DISCUSSION OF METHODOLOGY

The parameters derived for 0413 were extracted from various field manuals, instructional handouts, and firing tables. When the information was not available in the form required, subjective evaluations were made to convert that which was available into usable form. In many cases, there was no accessible recorded data, and persons with experience in the field were asked for their opinions.

### 1. Artillery Range Data Tables

The range data tables were prepared based upon subjective evaluation of which charges would be utilized to fire at a given range interval, and the percentage of the time that charge would be used provided a weighted average. Minimum range was determined as that range requiring an elevation of (approximately) 70 mils. Maximum optimal range was a subjective evaluation based largely upon the range when PER was judged too large. Maximum and minimum maximum ordinates were the largest and smallest for the interval of range and the charges which were selected for that interval. High angle fire was not considered in the computation of any data.

### 2. Naval Gunfire Data

Based upon discussions with qualified Naval officers, only the standard charge was considered for naval gunfire weapons. Thus only one maximum ordinate is listed.





3. Coverage

Artillery and mortar coverage was based upon the author's experience and FM 6-40. Coverage for naval gunfire was extrapolated to be consistent with other factors.

4. Observer Adjusting Rounds/Errors

The number of rounds in adjustment and the errors were based upon the author's experience.



155 RANGE DATA TABLE

RANGE	PER	PED	MAX MAX ORD	MIN MAX ORD
700-1200	5	0	28	22
1200-1700	7	1	66	37
1700-2200	10	1	123	42
2200-2700	12	1	204	68
2700-3200	12	2	233	101
3200-3700	14	2	337	100
3700-4200	15	2	477	139
4200-4700	18	2	675	180
4700-5200	20	3	546	241
5200-5700	21	3	711	300
5700-6200	23	4	933	379
6200-6700	24	4	808	450
6700-7200	25	5	1010	558
7200-7700	23	4	869	450
7700-8200	24	4	1043	563
8200-8700	25	4	1253	650
8700-9200	26	4	1521	782
9200-9700	29	4	1200	900
9700-10,200	27	4	1052	1052
10,200-10,700	28	4	1200	1200
10,700-11,200	29	4	1383	1383
11,200-11,700	30	4	1600	1600
11,700-12,200	31	5	1796	1796
12,200-12,700	32	5	2050	2050
12,700-13,200	33	5	2335	2335
13,200-13,700	35	6	2800	2800
13,700-14,600	37	7	3133	3133



105 RANGE DATA TABLE

<u>RANGE</u>	<u>PER</u>	<u>PED</u>	<u>MAX MAX ORD</u>	<u>MIN MAX ORD</u>
500-700	3	0	8	8
700-1200	5	1	34	29
1200-1700	7	1	81	55
1700-2200	9	1	154	102
2200-2700	11	1	212	129
2700-3200	13	2	257	143
3200-3700	15	2	378	202
3700-4200	18	2	551	375
4200-4700	19	3	527	279
4700-5200	22	3	720	357
5200-5700	20	3	604	449
5700-6200	20	4	772	432
6200-6700	20	4	992	529
6700-7200	19	4	835	639
7200-7700	20	5	1018	765
7700-8200	22	5	1246	910
8200-8700	16	5	1077	1077
8700-9200	17	6	1271	1271
9200-9700	18	6	1503	1503
9700-10,200	19	7	1789	1789
10,200-10,700	20	7	2175	2175
10,700-11,000	21	9	2932	2932



8" RANGE DATA TABLE

RANGE	PER	PED	MAX MAX ORD	MIN MAX ORD
1000-1300	4	0	20	20
1300-1800	5	1	46	46
1800-2300	6	1	85	45
2300-2800	7	1	137	72
2800-3300	8	2	207	107
3300-3800	9	2	296	151
3800-4300	11	2	413	204
4300-4800	12	2	568	124
4800-5300	13	3	790	161
5300-5800	15	3	430	205
5800-6300	16	3	534	257
6300-6800	17	3	656	317
6800-7300	18	4	801	387
7300-7800	20	4	976	467
7800-8300	21	4	1192	558
8300-8800	23	5	1476	660
8800-9300	24	5	774	774
9300-9800	25	5	902	902
9800-10,300	26	5	1044	1044
10,300-10,800	28	5	1203	1203
10,800-11,300	29	6	1380	1380
11,300-11,800	30	6	1579	1579
11,800-12,300	32	6	1804	1804
12,300-12,800	33	7	2062	2062
12,800-13,300	34	7	2365	2365
13,300-13,800	35	8	2734	2734
13,800-14,300	37	8	3225	3225
14,300-14,500	38	10	4223	4223





MORTAR/ARTILLERY WEAPON RANGE CAPABILITY

<u>WEAPON</u>	<u>MIN RANGE</u>	<u>MAX RANGE</u>	<u>OPTRG*</u>
81	100	3600	
105	500	11,000	10,000
155	700	14,600	10,000
8"	1000	14,500	11,000

\* OPTRG      Maximum Optimal Range



NAVAL GUNFIRE MAX ORD DATA

1. 3"/50

<u>Range</u>	<u>Max Ord</u>
1,000-1,500	4
1,500-2,000	8
2,000-2,500	14
2,500-3,000	22
3,000-3,500	36
3,500-4,000	51
4,000-4,500	77
4,500-5,000	104
5,000-5,500	147
5,500-6,000	194
6,000-6,500	262
6,500-7,000	332
7,000-7,500	412
7,500-8,000	592
8,000-8,500	638
8,500-9,000	792
9,000-9,500	944
9,500-10,000	1150
10,000-10,500	1355
10,500-11,000	1645
11,000-11,500	1930
11,500-12,000	2360
12,000-12,500	2820
12,500-13,000	3720



NAVAL GUNFIRE MAX ORD DATA (Cont.)

2. 5"/38

<u>Range</u>	<u>Max Ord</u>
1,000-1,500	4
1,500-2,000	8
2,000-2,500	14
2,500-3,000	22
3,000-3,500	34
3,500-4,000	47
4,000-4,500	67
4,500-5,000	88
5,000-5,500	116
5,500-6,000	152
6,000-6,500	198
6,500-7,000	246
7,000-7,500	302
7,500-8,000	383
8,000-8,500	458
8,500-9,000	563
9,000-9,500	663
9,500-10,000	795
10,000-10,500	921
10,500-11,000	1140
11,000-11,500	1245
11,500-12,000	1450
12,000-12,500	1645
12,500-13,000	1900
13,000-13,500	2150
13,500-14,000	2480
14,000-14,500	2800
14,500-15,000	3290
15,000-15,500	3800
15,500-16,000	4860



NAVAL GUNFIRE MAX ORD DATA (Cont.)

3. 5"/54

<u>Range</u>	<u>Max Ord</u>
1,000-1,500	4
1,500-2,000	7
2,000-2,500	13
2,500-3,000	23
3,000-3,500	29
3,500-4,000	38
4,000-4,500	52
4,500-5,000	66
5,000-5,500	87
5,500-6,000	105
6,000-6,500	132
6,500-7,000	158
7,000-7,500	188
7,500-8,000	227
8,000-8,500	265
8,500-9,000	318
9,000-9,500	366
9,500-10,000	431
10,000-10,500	495
10,500-11,000	579
11,000-11,500	656
11,500-12,000	761
12,000-12,500	859
12,500-13,000	990
13,000-13,500	1105
13,500-14,000	1260
14,000-14,500	1405
14,500-15,000	1585
15,000-15,500	1750
15,500-16,000	1970
16,000-16,500	2160
16,500-17,000	2410
17,000-17,500	2640
17,500-18,000	2940
18,000-18,500	3210
18,500-19,000	3500





NAVAL GUNFIRE MAX ORD DATA (Cont.)

5"/54 (Cont.)

19,000-19,500	3900
19,500-20,000	4250
20,000-20,500	4740
20,500-21,000	5230
21,000-21,500	5950
21,500-22,000	6940

4. 6"/47

<u>Range</u>	<u>Max Ord</u>
1,000-1,500	4
1,500-2,000	6
2,000-2,500	12
2,500-3,000	18
3,000-3,500	27
3,500-4,000	33
4,000-4,500	50
4,500-5,000	62
5,000-5,500	82
5,500-6,000	102
6,000-6,500	127
6,500-7,000	151
7,000-7,500	178
7,500-8,000	216
8,000-8,500	252
8,500-9,000	301
9,000-9,500	349
9,500-10,000	413
10,000-10,500	475
10,500-11,000	555
11,000-11,500	630
11,500-12,000	735
12,000-12,500	830
12,500-13,000	955
13,000-13,500	1065
13,500-14,000	1215
14,000-14,500	1360
14,500-15,000	1530



NAVAL GUNFIRE MAX ORD DATA (Cont.)

6"/47 (Cont.)

15,000-15,500	1695
15,500-16,000	1910
16,000-16,500	2100
16,500-17,000	2360
17,000-17,500	2580
17,500-18,000	2880
18,000-18,500	3150
18,500-19,000	3440
19,000-19,500	3815
19,500-20,000	4180
20,000-20,500	4660
20,500-21,000	5120
21,000-21,500	5920
21,500-22,000	6970



## MISCELLANEOUS DATA TABLE

### Naval Gunfire

1) Min/Max Ranges

a. Min Range = 1000 meters all weapons.

b. Max Range

3"/50 - 13,000

5"/38 - 16,000

5"/54 - 22,000

6"/47 - 21,000

2) Coverage Areas

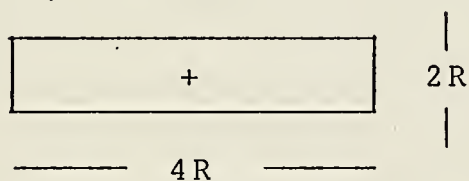
a. Single Round Radius

3" - 20

5" - 40

6" - 55

b. Area covered in FFE



(I.e., a rectangle centered at the computed impact point, with width  $4 \cdot R$  and depth  $2 \cdot R$ , based upon 2 weapons firing.)

3) Max No. Msns ( per ship )

a. 6"/47 - 2

b. 3" & 5" - 1



MISCELLANEOUS DATA TABLE (Cont.)

Artillery/Mortars Coverage

1) Single Round Radius

81mm	-	10
105mm	-	15
155mm	-	25
8"	-	40

2) Area coverage in FFE

A rectangle centered at computer impact point with dimensions:

	<u>Width</u>	<u>Depth</u>
81mm	100	50
105mm	180	50
155mm	300	75
8"	160	100





OBSERVER ADJUSTING ROUNDS/ERROR TABLE

<u>OBSERVER TGT RANGE</u>	<u>RDS IN ADJ</u>	<u>PER</u>	<u>PED</u>
0 - 300	0	0	0
300 - 600	2	25	10
600 - 1000	3	50	20
> 1000	5	100	30



## APPENDIX D - FIRE SUPPORT ROUTINE

### Instructor's Guide and Description

#### 1. GENERAL

The Fire Support Routine (FSR) is intended to provide to the student on battalion staff, primarily the Fire Support Coordination Center (FSCC), that input which would normally originate at company level in combat operations. The system is not intended, nor capable of, replacing the instructor input, but to partially relieve him of the burden of initiation of the continuous flow of traffic which would be expected during operations. Instead, student decisions interact with the logic within the machine, and a reaction is generated. The instructor, in the capacity of unit controller, may pass the reaction directly to the student, or, if he desires to stress some teaching point, alter the reaction to the situation.

In addition, due to the complexity of the combat environment, it is not possible to model every contingency. Hence, there are limitations to the internal logic, of which the instructor (unit controller) must be aware. This guide is to present an overview of the FSR and outline the responses which should be expected as well as some of the limitations that are inherent.

If specific details of the logic flow are desired, see the detailed descriptions of the various routines.



## 2. STRUCTURE

The FSR is sub-divided into six major subordinate routines, as well as a number of subroutines. The subordinate routines are:

A. Fire Support Main - to coordinate the activities within the FSR.

B. Weapon Selection Routine - to select a supporting arm to request for an internally generated mission.

C. Artillery Unit Selection Routine - to select an artillery unit to fire a particular artillery mission, student or internal.

D. Artillery Shoot Routine - to compute the times and rounds for fire for effect (FFE) and perform the bookkeeping requirements for artillery missions.

E. Mortar Shoot Routine - to select a section to fire and compute times and rounds for FFE, as well as perform the bookkeeping requirements for mortar missions.

F. Naval Gunfire Shoot Routine - to coordinate naval gunfire missions, select the caliber to fire, compute the times and rounds in FFE, and perform the bookkeeping requirements.

## 3. FUNCTIONS

A. Functioning of the FSR is divided into three broad categories:

(1) Simulation of requests from companies for supporting arms.



(2) Simulation of portions of the supporting arms logic and the bookkeeping required to track supporting arms availability.

(3) Simulation of the reaction between student decisions and the supporting arms systems, and providing a reasonable outcome of the effect upon supporting arms availability.

B. The general sequence will be for the machine to develop a situation based upon student orders to the units, and determine that there exists a requirement for support. This provides entry to the FSR, which will select a weapon system and submit a request through the FSCC. The FSCC may approve the mission, cancel the mission, or make desired changes. (Student missions enter at this point as approved missions.)

Specific approval is required from the student before the mission will progress further. Once the approval is given, air missions remain with the students for handling (see paragraph 12.A.), and other missions re-enter the FSR for the selection of a unit and determination of time and rounds in FFE. This information is passed to the student in a "Shot Message" and to other routines within the machine for casualty assessment and determination of combat results.

C. The third functional area is contained within the results of the first two. The selection of a weapon system, the delay from the initiation of the request for fire, and the availability of support are all dependent upon what missions the student has assigned, the ammunition resupply, the location of restrictive fire plans, and other student input. When a decision has been made to request support and units are prevented from firing, the student is informed.





#### 4. INITIAL INPUT

- A. All unit locations (to include naval gunfire support ships) upon entry into the battle area.
- B. Artillery unit "missions"
  - (1) If attached and to which unit
  - (2) Reinforcing and which unit
  - (3) Decentralized or centralized FDC for units not attached.
- C. Mortar section missions - attached or normal.
- D. Artillery and mortar ammunition reorder points.
- E. Priorities of fires if assigned.
- F. Battalion to which each 105 battery is providing forward observers.
- G. Companies to which Naval Gunfire Spot Teams and Forward Air Controllers (FACs) are assigned.
- H. Restrictive Fire Plans (RFPs)
  - (1) Endpoint coordinates of the centerline
  - (2) Minimum altitude
  - (3) Maximum altitude
  - (4) Width. (This information is not used within the logic of the FSR for 0413, but is retained to maintain realism.)

#### 5. PLAYER GAME INPUT

- A. Any changes from paragraph 4 above.
- B. The location for artillery preplanned on call targets.
- C. Move orders for artillery and mortar units.



D. Ammunition resupplies.

E. Amount, type, and time of air delivery of ordnance. (See paragraph 12.A.)

F. Student mission requests

(1) Grid location

(2) Weapon system (Mortar, artillery, or naval gunfire)

(3) Priority

(4) Target type (See paragraph 9)

(5) Artillery target type, if for artillery. (0 = 8 inch only;

1 = any artillery).

## 6. MISSION GENERATION LOGIC

### A. Close Combat

Upon entry into close combat, support is automatically requested. For air requests, the student will determine the time and amount of ordnance delivery, but no additional request will be submitted. For other systems, once the mission has been approved, fire is continued until contact is broken. When contact is broken the mission is canceled, unless artillery is firing and the contact is broken due to landing force losses, in which case three additional FFEs are delivered before cancellation.

### B. Sighting

Each enemy unit sighted is taken under fire by supporting arms. For mortars, artillery, and naval gunfire, a single fire for effect is delivered, unless the ground forces are closing, and then fire is continued. Air requests, as above, are handled by the student.



## 7. WEAPON SYSTEM SELECTION LOGIC

A. Weapon systems for student generated missions are selected by the student.

B. Weapon systems for internally generated missions are selected on the basis of the combination of a number of factors. Some of the more significant of these factors are:

(1) Proximity of the landing force unit to the target.

(2) Tanks and self-propelled artillery units are always engaged by air.

(3) Except for (2) above, naval gunfire and air are requested only when there is a naval gunfire spot team or a FAC available.

(4) Enemy unit size.

(5) Proximity of the target to any artillery on call.

## 8. MISSION PRIORITIES

Mission priorities are assigned in the weapon selection routine.

Close combat missions are always assigned priority 1. Armor targets are always assigned priority 1. Other targets are assigned priorities 2 to 5, depending in general upon the same factors as for weapon selection. The priorities are used to insure that a routine mission does not supersede a more important one, such as in support of a unit in close combat.

## 9. TARGET TYPE

A. All targets are categorized into one of seven types:

(1) Infantry in the open or hasty defense

(2) Infantry in a dug in defense



- (3) Infantry in prepared positions
- (4) Tanks or self-propelled artillery
- (5) Towed artillery
- (6) Infantry moving in APCs
- (7) Infantry moving in trucks, or a support unit.

B. Students must designate one of these types upon entry of a mission into the FSR for student generated requests.

#### 10. RESTRICTIVE FIRE PLANS (RFP)

Restrictive Fire Plans are utilized to limit the amount of artillery and naval gunfire which can be delivered. Both systems are restricted from firing through the space by machine logic. However, since there is no provision to limit aircraft to the RFPs, the unit controller must insure that the student is forced to establish those RFPs which would be required by the air activity.

#### 11. ON-CALL TARGETS (PREPLANNED TARGETS)

On-call targets, referred to elsewhere as preplanned targets, are maintained only for artillery, and generated only from student input. Student input of a grid location is used to assign a unit to fire. Calls for fire on this target will result in faster delivery of fire for effect if the assigned unit is not prevented from firing by an RFP or other missions. Internally generated missions will be assigned as a preplanned mission if the target is within a 100 X 100 meter box of a preplanned target.

All preplanned targets assigned to a unit are canceled when the unit moves. If the student desires to maintain the target as an on call, it must be resubmitted.





## 12. WEAPON SYSTEM LOGIC

### A. Air

(1) Air is always requested for internally generated missions against target type 4. Against other target types, air is requested only if a FAC is assigned to the company and other conditions are met, with the exception of target type 1, which is never assigned to air.

(2) For target type 4 when no FAC is assigned to the company, the request is sent to the appropriate battalion FSCC. For other requests for air support from the FAC, the mission is submitted directly to the Direct Air Support Center (DASC), with an information copy to the FSCC.

(3) Once the request is sent, no further action is taken internally. The students are expected to manually fly the mission and input the time, type, and amount of ordnance delivered.

(4) There is no observer error observer time delay with air missions. The time of the mission is the time of initial sighting, with no preparation time.

(5) There is no internal provision to insure aircraft safety from friendly ground fire. Students are expected to insure that aircraft remain within restricted air space or that no fires are being delivered which would endanger the craft. Instructors (controllers) should check aircraft flight paths against known missions, and assess appropriate penalties.

### B. Artillery

(1) Internal artillery missions may be generated against all target types except 4.



- (2) Once student approval is given, or a student mission input, a unit is selected to fire based upon a number of factors, to include:
- (a) An attached unit can fire only in support of the unit to which attached.
  - (b) A mission sent to an attached unit can be passed only to a unit assigned reinforcing to the attached unit.
  - (c) If available, the unit assigned a preplanned will fire any preplanned mission.
  - (d) If available, the unit normally providing forward observers will fire for the supported unit.
  - (e) 105 and 155 batteries are limited to two missions simultaneously. There is no decrease in reaction time or amount of fire for two missions. 8-inch platoons are limited to one mission.
  - (f) The battalion FDC has access to all units not attached, with no reaction time loss.
  - (g) Under decentralized FDC, missions can be passed to the battalion FDC for assignment to other units, but with a time penalty, fixed at 10 minutes.
  - (h) If no unit is available to fire a mission, and the new mission is of higher priority, the lowest mission being fired by units otherwise capable of firing is canceled.
  - (i) If a mission is not of high enough priority to warrant cancellation of another, and the company calling has been assigned priority of fires, the lowest priority mission being fired by a unit



otherwise able to fire but engaged with another infantry unit mission, is canceled.

(j) No **artillery** is fired through restrictive fire plans.

(k) Artillery units are precluded from firing while moving, i.e., hip shoots.

(3) Artillery missions generated internally have an observer error included in the target location, unless the mission is in support of close combat. The first round of observed missions (all internally generated) and the initial FFE for student missions include a ballistic error. These errors are included to increase realism and to provide for additional play by students in the FSCC, who must now take measures to insure troop safety. All fires for effect on observed missions are assumed on target without error.

(4) For missions in support of close combat, the number of rounds delivered in effect is doubled for the second FFE and reinforcing fires are automatically requested for the third FFE. These fires will continue until close combat is terminated.

### C. Mortars

(1) Missions for mortars are generated internally only against target type 1.

(2) No observer or ballistic error is generated for mortar missions.

(3) For mortar missions from units with a section attached, no request is submitted to the FSCC, but the FSCC is advised that the unit is firing.



(4) Each section is limited to one mission. If the platoon is centralized, four missions may be fired simultaneously with no decrease in number of rounds in FFE or reaction times.

(5) RFPs do not affect the firing of mortars.

D. Naval Gunfire

(1) The Naval Gunfire Shoot Routine was constructed specifically for the ships assigned to 0413.

(2) Naval gunfire requests are generated internally only when there is a naval gunfire spot team assigned to the company, and against target types 3, 5, or 6.

(3) A maximum of one direct support (DS) ship per infantry battalion, and one general support (GS) ship can be controlled. Since no missions are generated unless a spot team is assigned, and each spot team is associated with a DS ship, no missions are generated for the GS ship.

(4) Each ship is limited to one mission per caliber, except the 6 inch, which is limited to two.

(5) Each mission is sent to the DS ship in support of the battalion involved, and assigned to the lightest weapon available to fire. If the ship cannot fire, the mission is canceled and the FSCC advised.

(6) Ships are assumed in fixed positions. Any movements must be input by the student.





\*\*\*\*\* (7) THERE IS NO PROVISION FOR CHECKING GUN-TARGET LINE! The student or controller must provide a check on the gun target line for naval gunfire to prevent missions on the line too close to landing force units. \*\*\*\*\*

(8) Naval gunfire is precluded from firing through restricted air space.

### 13. GENERAL LIMITATIONS

A. There are no provisions to accept schedules of fires. Student schedules of fires must be input as normal or preplanned missions, with the number of rounds to be fired and the reaction times fixed by machine logic.

B. The number of rounds for all weapons except air are fixed by target type.

C. Missions canceled because of lack of availability of the weapon system requested are deleted, and no re-request is made.

D. No preplanned targets are generated internally, and only artillery has any preplanned mission logic.

E. Ammunition is limited to high explosive.

F. All rounds in fire for effect are delivered simultaneously, and the time required for delivery is independent of the number of rounds fired.

### 14. ENEMY FIRE SUPPORT

The only provision for enemy fire support is artillery. The only internally generated missions are those in support of close combat. All internally generated missions are assigned priority two, and any unit



within range not engaged in mission can fire. Fire will continue until the contact is terminated or the mission canceled. Unit controllers have the capability to override internally generated missions by requesting a mission with a priority of one. All missions other than in support of close combat must be requested by the unit controller.



## LIST OF REFERENCES

- Abridged Range Tables for U.S. Naval Guns, NAVORD OP1188, Change 1, Naval Ordnance Systems Command, 24 March 1947/28 February 1964.
- Air Support, FMFM 7-3, United States Marine Corps, 10 February 1966.
- Commandant of the Marine Corps Letter A03C52-ljh: to Commanding General, Marine Corps Development and Education Command, Subject: Project Directive for Tactical Exercise Simulator and Evaluator, 30 October 1969.
- Commandant of the Marine Corps Letter A03C51-sl: to Commanding General, Marine Corps Development and Education Command, Subject: Advanced Development Objective (ADO) No. CT-01X: Tactical Exercise Simulator and Evaluator (TESE), 6 May 1971.
- Commandant of the Marine Corps Letter AX/A03C51-lag: to Commanding General, Marine Corps Development and Education Command, Subject: Tactical Warfare Simulation, Evaluation and Analysis Systems Study and Management Project Directive, 20 January 1972.
- Computer Sciences Corporation, Tactical Exercise Simulator and Evaluation System Design Specifications Study, Final Report, 15 April 1972.
- Development Center, Marine Corps Development and Education Command, Tactical Warfare Simulation Evaluation and Analysis Systems Study (TWSEASS) Project 31-70-01 Third Interim Report, 29 October 1971.
- Dictionary of Military and Associated Terms, JCS Pub. 1, Joint Chiefs of Staff, 3 January 1972.
- Field Artillery Cannon Gunnery, FM 6-40, Department of the Army, 5 October 1967.
- Firing Tables for Cannon, 105mm Howitzer, Firing Cartridges, HE, M1, FT 105-H-6, C-7, Department of the Army, 29 December 1967
- Firing Tables for Cannon, 155mm Howitzer, Firing Projectile, HE, M107. FT 155-AH-2, C-2, Department of the Army, 31 October 1967.
- Firing Tables for Cannon, 8-Inch Howitzer, Firing Projectile, HES, M424. FT 8-0-4, Department of the Army, 30 June 1967.
- Infantry Mortars, ECP 2-31, Education Center, Marine Corps Development and Education Command, 20 April 1971.
- Naval Electronics Laboratory Center TESE Technical Memorandum TN-1.1-02, Lesson A(A)0413, MAB in an Amphibious Operation, Design Specifications, Rough Draft, undated.



Naval Gunfire Reference Data, Education Center, Marine Corps Development and Education Command, July 1970.

Naval Gunfire Support, FMFM 7-2, United States Marine Corps, 27 August 1962, w/Change 1, 14 January 1966.

Range Table for 3-Inch 50-Caliber Gun, Firing Projectile Mark 33 Mod 0 (Surface Targets), NAVORD OP 1795, Naval Ordnance Systems Command, 15 September 1966.

Range Table for 5-Inch 38-Caliber Gun Mark 12, Firing FCL(VT) Projectile Mark 49 and MODS (Surface Targets), NAVORD OP 551, Change 3, Naval Ordnance Systems Command, 10 May 1958/15 August 1969.

Range Tables for 5-Inch 54-Caliber Guns Mark 16, Mark 18, and Mark 19, Firing FCL(VT) Projectile Mark 41 and MODS (Surface Targets), NAVORD OP 1182 Change 6, Naval Ordnance Systems Command, 24 March 1958/1 August 1970.

Range Table (Surface Targets) for 6-Inch 47-Caliber DP Gun, OP 1612, Bureau of Ordnance, 28 April 1947.

Range Table (Surface Targets) for 6-Inch 47-Caliber DP Gun, OP 1614, Bureau of Ordnance, 28 April 1947.





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ABSTRACT

This paper develops fire support logic for use in educational war game simulating ground combat at the platoon/company level. Included within the logic are provisions for:

- 1) Given a requirement for supporting fires, selecting a weapon system: mortars; artillery; naval gunfire; or air.
- 2) Selection of an artillery unit to fire.
- 3) Generation of amount and time of ordnance delivery for mortars, artillery and naval gunfire.

Work was coordinated with the development of the Tactical Exercise Simulator and Evaluator (TESE) by the United States Marine Corps, and was integrated into the initial models for testing and refinement.



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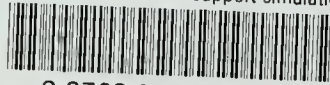
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