CHAPTER 4

EXAMPLE PROBLEMS

4-1. GENERAL

Several example problems have been developed in order to demonstrate the use of AFCS for military planning, design, etc. The problems range from simple data extraction from the various manuals to a complex planning problem. Since AFCS is an extensive system with a broad range of facility types, it is not possible to cover all available facilities; however, the general procedures for using the system are the same for all facility types. Therefore, the example problems in this chapter should provide adequate guidance.[1]

4-2. MULTIPLE CHOICE PROBLEMS (TABLE CONSULTATION)

The purpose of these problems is to (1) familiarize the user with the AFCS installation and facility numbering systems and (2) teach the user how to extract component data from the various manuals. The problems demonstrate how facilities and installations can be combined to meet any desired function; they also show the user how to select the components that best meet a function's requirements.

a. Example problem 1.

(1) Problem Statement. A troop camp must house 1,700 military personnel in the temperate zone (temporary standard of construction). Which of the combinations of installations listed in *(a)* through *(c)* below will meet that requirement for the least cost? What will be the estimated construction effort required?

(a) Two NT1531

(b) One NT1531 and two NT1231

(c) One NT1531 and three NT1131

(2) Solution. Determine the cost of each installation from data in TM 5-301-1. (Note that shipping costs, the costs of hiring civilian labor, etc., are not included.) Also, verify the capacity of the cantonment.

(a) If one NT1531 costs $516,813, then:

$516,813 x 2 = $1,033,626 for 2,000 personnel

(b) If one NT1531 costs $516,813 and one NT1231 costs $44,242, then:

$516,813 + 2($44,242) = $605,297 for 1,750 personnel

(c) If one NT1531 costs $516,813 and one NT1131 costs $71,271, then:

$516,813 + 3($71,271) = $730,626 for 1,750 personnel

Although all of the installations can meet the 1,700-person capacity requirement, choice *(b)* is the least expensive. The estimated construction effort for this combination would be:

Construction Effort in Man-Hours				
Installation	Horizontal	Vertical	General	Total
NT1531	19,603	14,310	11,192	45,105
NT1231 (2)	4,428	3,892	3,314	11,634
Total	24,031	18,202	14,506	56,739

b. Example Problem 2.

(1) Problem Statement. A hospital having at least a 700-bed capacity is required in the temperate zone (initial standard of construction). Which of the installations or combinations of installations listed in *(a)* through *(c)* below can meet that requirement with the least effort?

(a) One GH0521 and two GH0121

(b) One GH0521 and one GH0221

(c) One GH0721

(2) Solution. Obtain cost information from the installation section of TM 5-301-1. Also, verify the hospital's required capacity. Calculate the man-hours (MH's) in order to find the least construction effort.

(a) If one GH0521 (500 beds) takes 28,021 MH and GH0221 (100 beds) takes 14,184 MH, then:

28,021 MH + 2 (14,184 MH) = 56,389 MH for 700 beds

(b) If one GH0521 (500 beds) takes 28,021 MH and one GH0221 (200 beds) takes 14,483 MH, then:

28,021 MH + 14,483 MH = 42,504 MH for 700 beds

1. Costs and man-hours used in the examples may not be current but are valid for comparison purposes.

(c) If GH0721 (750 beds) takes 33,431 MH, then it meets the 700-bed requirement and uses the least construction effort.

c. Example Problem 3.

(1) Problem Statement. Which installation listed in *(a)* through *(d)* below would be a suitable PECS installation for use with general construction and renovation?

(a) YY1009

(b) YY1029

(c) YY1049

(d) YY1059

(2) Solution. Refer in TM 5-301-1 to the installation description for each installation number listed in *(a)* through *(d)* above. YY1029 is the only one that indicates use with general construction and renovation work.

d. Example Problem 4.

(1) Problem Statement. A 6,600-square-foot area of warehouse space is required in a materiel receiving area. For a wood frame building, which of the combinations of warehouses listed in *(a)* through *(d)* below would best satisfy the storage area requirement?

(a) Three 44220DA and one 44220BA

(b) Six 44220CA and one 44220BA

(c) One 44220EA, one 44220DA, and one 44220BA

(d) Five 44220CA and one 44220DA

(2) Solution. The information needed for tabulating the square footage of each facility has been taken from TM 5-301-1. Therefore, if:

- 44220BA is 600 square feet
- 44220CA is 1,000 square feet
- 44220DA is 2,000 square feet
- 44220EA is 4,000 square feet

then:

(a) 3(2,000) + 1(600) = 6,600 sq ft

(b) 6(1,000) + 1(600) = 6,600 sq ft

(c) 1(4,000) + 1(2,000) + 1(600) = 6,600 sq ft

(d) 5(1,000) + 1(2,000) = 7,000 sq ft

Answers *(a)*, *(b)*, or *(c)* appear to be valid choices if considering only square footage, since they meet, but do not substantially exceed, the 6,600 square foot requirement. However, a complete analysis would also consider procurement and shipping costs as well as the construction effort in man-hours, making *(c)* the most practical choice.

4-3. SIMPLIFIED LEAD-THROUGH PROBLEMS

These problems show the user how to compile a list of facilities or installations in order to meet certain functional requirements. Figure 4-1 shows a flowchart of the general procedure.

a. Example Problem 5. Construct a 300-bed hospital for use in a temperate climate (wood frame, temporary construction standard). Also, provide an electrical power generator (208/120 V, 60 Hz) and a generator building, as necessary. No existing facility can be used to fulfill any part of the requirements. The solution procedure is described in paragraphs *(1)* through *(8)* below:

(1) Step 1. Identify the climatic zone. Use TM 5-301-1, since the facility will be in the temperate zone.

(2) Step 2. Determine whether to look for the data under the Listing of Installations or under the Listing of Facilities. An installation is a group of facilities designed to provide a specific service. A hospital, therefore, would be an installation because it is made up of facilities such as an administration building, surgery buildings, laboratories, staff housing, recreation buildings, a water distribution system, and electrical distribution. If you do not know how to determine whether a unit is an installation or a facility, it is easiest to consult the Listing of Installations first and then the Listing of Facilities.

(3) Step 3. Check the index of the Listing of Installations in TM 5-301-1 for temperate climates. Locate the page where "Hospital" begins. Review each hospital installation until the required size, standard of construction, and type of construction is found. The best choice appears to be GH0361. Beneath the description of the installation is a list of its numbered facilities. Become familiar with all information on the page. When GH0361 is ordered, all of the facilities listed will be supplied. Also note the shipping and construction effort information, which can be of great value to the planner. For example, the utilities provisions are given: 15,000 gallons of water per day, 10,500 gallons of sewage per day, and 1,203 kW electrical power.

(4) Step 4. Check whether the final product will require additional facilities or installations. For example,

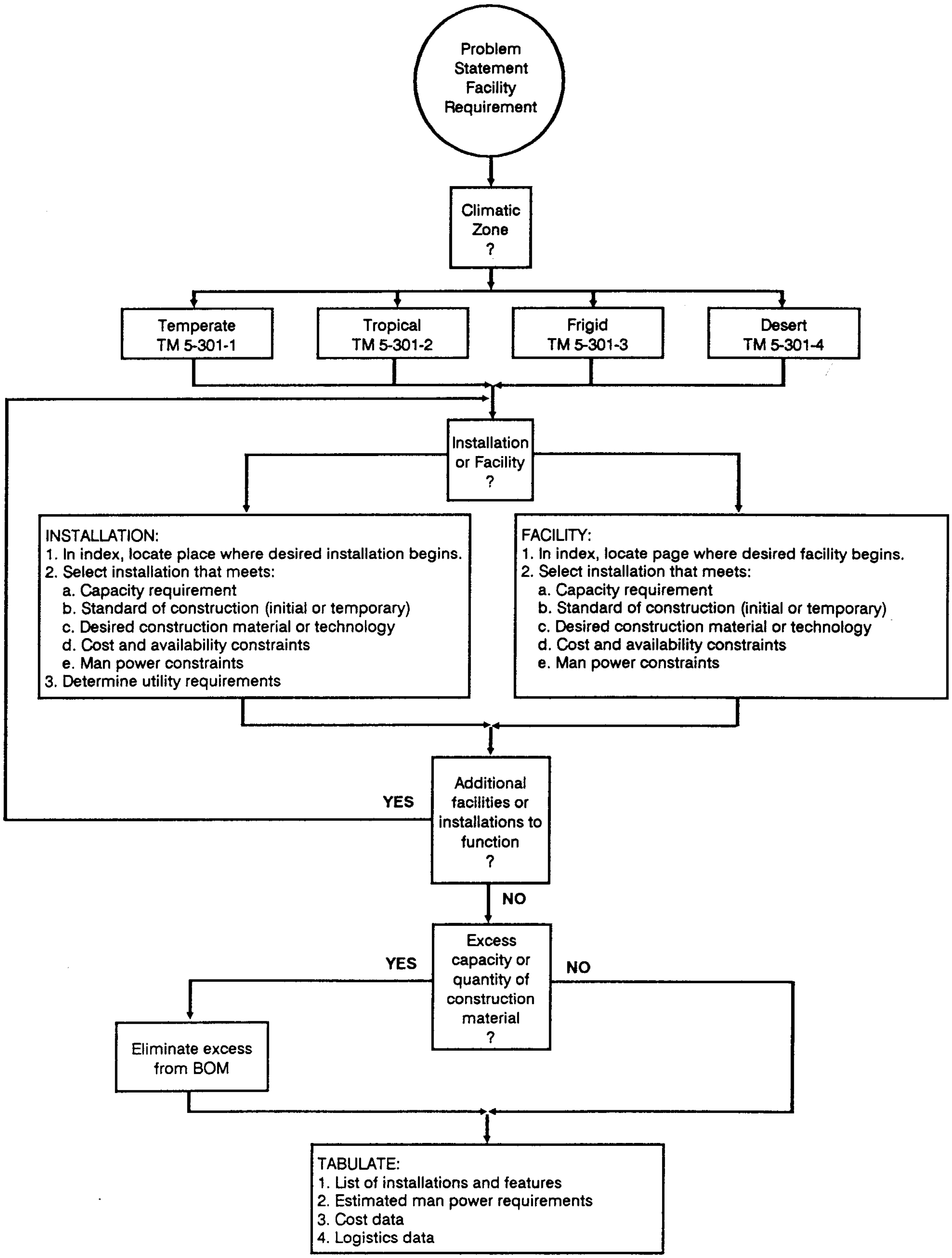

Figure 4-1. Procedure for solving lead-through problems

Table 4-1. Tabulations for example problem 5

	Quantity	Materials			Construction Effort in Man-Hours			
		Weight short tons	Volume measured tons	Cost $	Horizontal	Vertical	General	Total
GH0361	1	2,711	3,354	980,188	5,387	89,694	11,732	106,813
81110GA	1	57	90	63,325	51	1,611	493	2,155
Total	–	2,768	3,444	1,043,513	5,438	91,305	12,225	108,968

according to paragraph *a* above, an electrical power generation plant should be provided.

(5) Step 5.

(a) Begin a search for the electrical generating plant. The required capacity must be at least 1,203 kW, according to the installation description. Consult the index to the Listing of Facilities in order to locate the page where "Electrical Generation and Distribution Equipment" begins. Search for a plant that provides 1,203 kW. Since the next plant larger than 1,230 kW is a 1,500-kW facility, you must decide whether it would be best to over design slightly or over design considerably.

(b) With that decision in mind, review the available generating plants, 81110GA through 81110GK. Using information from the facility description and drawing, you can narrow the possible choices to 81110GA, 81110GB, and 81110GC. All are temporary standard of construction facilities and each includes a building.

(c) The facility description and the schedule of facilities and drawings on sheet 81110GA-GK, sheet 1, (in TM 5-302) show, however, that for the 1,500-kW generating plant, four 500-kW generators are actually installed, and for the 2,000-kW generating plant, five 500-kW generators are installed. Because of the reserve capacity of 81110GA and the fact that the peak demand of 1,203 kW would be 1.5 percent greater, the best choice would be the 1,500-kW generating plant, 81110GA.

(6) Step 6. After all of the required installations or facilities are picked, check if any existing facilities can fulfill part of the requirement. If so, the new facilities that are redundant can be eliminated from the list of components to be acquired.

(7) Step 7. Complete the list of installations and facilities, and tabulate the logistics and cost data and construction effort as shown in table 4-1. Consult TM 5-303 (BOM) for a detailed list of materials and construction effort estimates. The items in paragraphs *(a)* and *(b)* below should be considered when using TM 5-303:

(a) TM 5-303 provides a detailed list of materials for each facility in order to ensure that specific items are not omitted. However, do not assume that the BOM is absolutely correct. Although the BOM measures materials by units and tenths of a unit of issue for each facility, smaller increments may actually be required.

(b) When using the construction effort estimates to figure the total duration, consider any unusual or extenuating circumstances (such as troops adjusting to a very hot climate) .

(8) Step 8. TM 5-302 contains all relevant construction drawings. The drawing numbers for installation GH0361 are listed in the installation index in TM 5-302. (The drawing uses the same number as the installation.) Note that drawings for the individual facilities, such as the generator plant, are determined by the facility number. For example, drawings for the generator facility 81110GA are found on 81110GA-GK in TM 5-302.

b. Example Problem 6. Construct, for a temperate climate, a port facility to handle 1,000 tons of break-bulk cargo per day. Assume a tidal range of approximately 15 feet and use the temporary construction standard and wood frame buildings. Assume that an additional 8,000 square feet of warehouse space will be required. Utilities (electricity and water) need not be provided, since they will be supplied from a nearby installation. The solution procedure is described in paragraphs *(1)* through *(6)* below.

(1) Step 1. Identify the climatic zone. Since the facility will be in the temperate zone, use TM 5-301-1.

(2) Step 2. Determine whether to look for the data under the Listing of Installations or under the Listing of Facilities. Since a port will consist of many facilities, such as a pier, wharf, building, and warehouses, it would be listed as an installation.

(3) Step 3. Check the index of the Listing of Installations for temperate climate in TM 5-301-1. Locate the page where "Port, Break-Bulk Cargo" begins. Review

Table 4-2. Tabulations for example problem 7

	Quantity	Materials			Construction Effort in Man-Hours			
		Weight short tons	Volume measured tons	Cost $	Horizontal	Vertical	General	Total
FP1105	1	122,485	138,731	97,029,518	136,833	165,338	99,618	401,789
44110EA	2	10	11	1,943	23	262	53	338
Total	–	122,495	138,742	97,031,461	136,856	165,600	99,671	402,127

each port installation until the required size, standard of construction, and type of construction are found. The best choice appears to be FP1105.

(4) Step 4. Check whether the final product will require additional facilities or installations. For example, this problem requires an additional 8,000 square feet of warehouse space.

(5) Step 5. To fill the extra warehouse space requirements, search through the Listing of Facilities as described in step 3 of example problem 5 above, or check for the facilities listed under the selected installation. Facilities that exactly match the requirements can be ordered. For instance, facility 44110EA (which is one of the components of installation FP1105) is a closed, wooden warehouse with a capacity of 4,000 square feet. The additional space required is 8,000 square feet; therefore, ordering two additional warehouses of type 44110EA would meet the requirement.

(6) Step 6. The remaining procedures are the same as in steps 6, 7, and 8 of example problem 5 above. Tabulate the cost, logistics, and construction data as shown in table 4-2. The drawing number listed in the installation description is FP1015-1065. The drawing number for the wood frame warehouse building is 44110BC-44110EK. Both of these drawings are in TM 5-302.

c. Example problem 7. Construct, for the temperate zone, a basic 20-foot-wide by 70-foot-long by 8-foot-high wood frame building with concrete foundation. Insulation will be required for the walls and ceiling. The building is to be temporary standard of construction. (Note that all wood and steel frame buildings in AFCS are designed for temporary standard of construction.) Utilities for the building will be installed later and are not be a part of this problem. The solution procedure is described in paragraphs *(1)* through *(4)* below.

(1) Step 1. Use TM 5-301-1, since the building will be located in the temperate zone.

(2) Step 2. Check the index of the Listing of Facilities under "Buildings, Wood," since an individual building that does not provide any specific service should fall under the facility category.

(3) Step 3.

(a) A review of the facility section under wood frame buildings shows that no building listed exactly fits the stated requirement; therefore, several subfacilities of components must be assembled. Examine the facility listing carefully, looking for compatible components.

(b) Facility 93121AK provides a complete 20-by-60-foot basic building with a concrete floor and all required windows and doors indicated in the design (see figure 4-2). The design permits the construction of any length building in the 20-foot-wide series; however, only selected standard AFCS lengths are presented with descriptions and material lists. In order to construct a nonstandard 70-foot-length building, the planner would use the 60-foot building and add the following components:

- 1 each 93121HB, 10-foot interior bay
- 1 each 93191GA, concrete-footing stem wall, 20 feet
- 0.2 each 93191GF, concrete slab floor, 4-inch-thick, 1,000 square feet
- 1 each 93195AC, window, 4 by 4 feet (if required)
- 1 each 93195AB, personnel door (if required)

(c) Remember, the design allows the construction of any length without a design change. The following additional building enhancements could be selected by the planner, depending on the intended construction site and building use:

- 93192AA-JH, electrical designs
- 93194AA-JF, interior components
- 93195AA-AC, exterior components
- 93196AA-AE, insulation

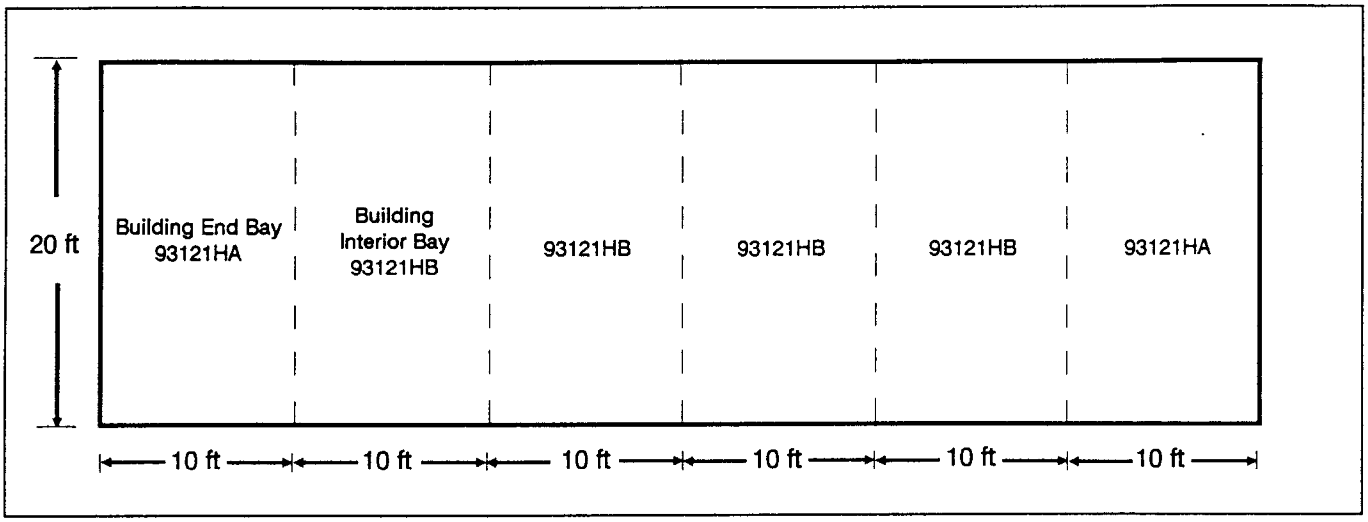

Figure 4-2. Components of a 20-by-60-foot building

- 93197AA-AD, ventilation
- 93198AA-AY, air-conditioning

(4) As a rule, all subfacilities are compatible with all building systems; however, some building components for pre-engineered metal, fabric frame, or lightweight panelized buildings must be procured as part of the structure itself. Those components include insulation, some ventilation components, window, doors, and tropical eaves. When combining components or subfacilities for a final product such as a building, use subfacilities from the same or a compatible system.

4-4. USING AFCS IN PLANNING AND DESIGN

a. General Procedures. Figure 4-3 show a flowchart of the general procedure for using AFCS in planning and design. Information and directives from higher planning headquarters and information from local sources that must be considered during various steps of the procedure are shown in large circles. The decision point and check point are shown in squares, the outputs of specific steps in rectangles, and inputs from AFCS manuals (TM 5-301, TM 5-302, and TM 5-303) in small circles. Each item is tagged with its corresponding paragraph number.

b. Sources for Information and Directives. Information and directives from higher-planning headquarters and information from local sources are described in paragraphs *(1)* through *(5)* below:

(1) Base Development Plan (BDP) and Construction Directives. The major directive may include selected base sites, assigned support mission, operational target dates, scope of construction requirements, etc. The plan may also specify priorities and construction standards and allocate resources and real estate.

(2) Terrain Information and Requirements. Terrain information includes map reconnaissance, site reconnaissance, climate, and soil. Terrain requirements are provided in the BDP, which specifies concealment requirements and the level of mobility expected.

(3) Available Existing Facilities. Information about existing facilities could come from higher-planning headquarters or local intelligence sources. Existing facilities may include buildings, utilities, roads, etc.

(4) Local Resources. Information about local resources could come from intelligence sources. Local resources include availability of skilled craftsmen, general construction labor, and construction materials such as steel, lumber, cement, and aggregate.

(5) Construction Resources. Construction resources include both the engineer unit or units assigned by the higher-planning headquarters and any available civilian laborers who will perform the construction tasks.

c. Decision and Verification Points. Decision and verification points are described in paragraphs *(1)* and *(2)* below:

(1) Materials and Construction Technology. The choice of materials depends largely on the facility type and is constrained by the standard of construction. Several types of construction technology are available through AFCS, including wood frame, steel frame, and

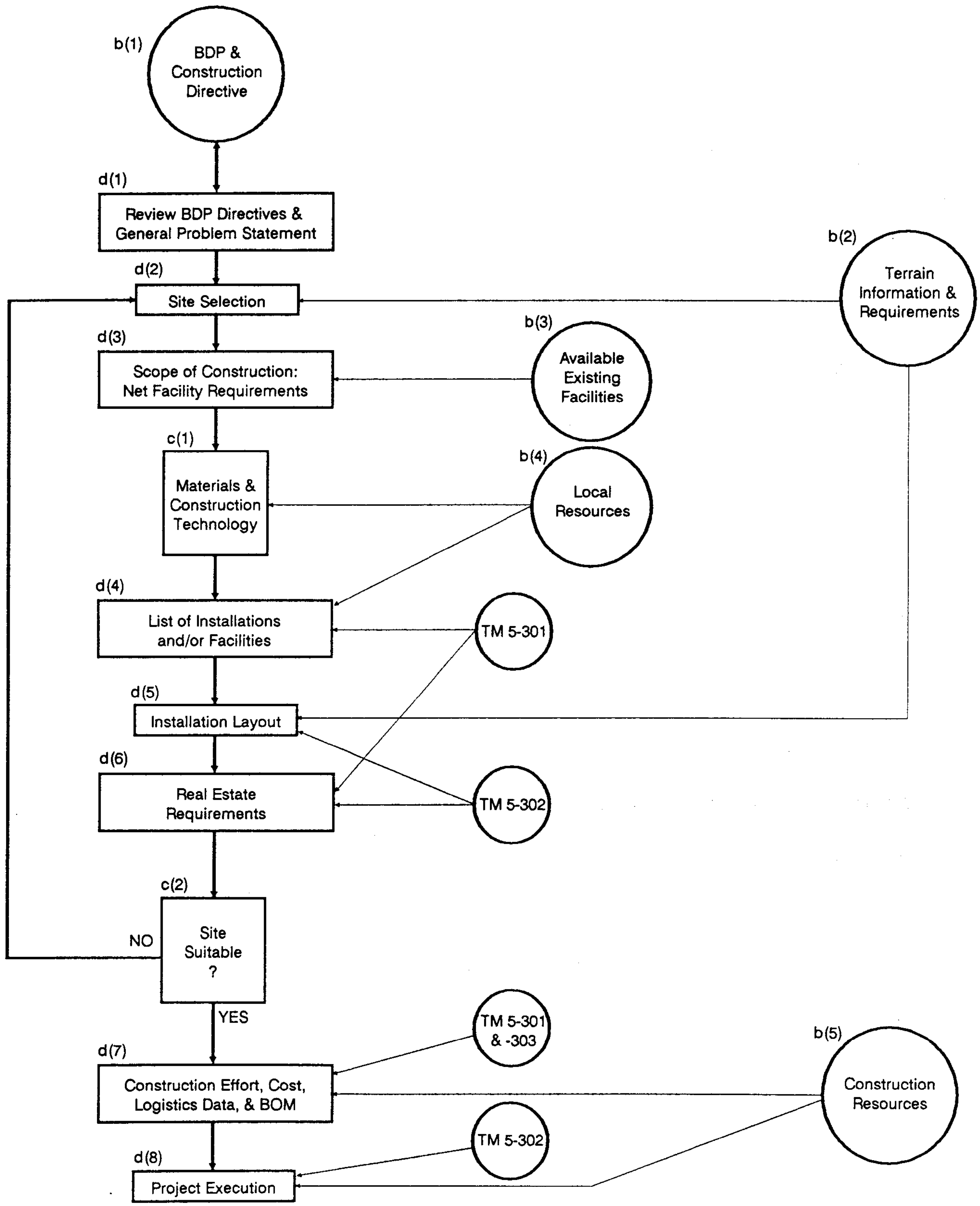

Figure 4-3. AFCS planning and design procedure flow

prefabricated buildings. The selection of a particular building type should be based on the availability of materials, time constraints, and the types of skilled craftsmen needed.

(2) Site Suitability. The estimates of total real estate requirements are based on the final installation layouts. The results are compared with those of the previously selected or assigned sites, and then steps are taken to acquire any needed additional land.

d. Planning, Design, and Estimating. The planning, design, and estimating stages that generate requirements are explained in paragraphs *(1)* through *(8)* below:

(1) General Problem Statement. The BDP should be reviewed for thoroughness and consistency; then, a general problem statement should be formed. The statement should consist of military plans and support requirements in terms of the tasks to be done by the construction unit and the resources available to do them. The statement should also include information about size, location, climate, standard of construction, etc.

(2) Site Selection. The land estimate is based on the construction requirements. Information about candidate sites is evaluated, using the estimate and the terrain requirements. The most promising sites are inspected by a reconnaissance team, and then a site is chosen.

(3) Scope of Construction. The net facility requirements can be determined by examining the overall facility requirements and any usable existing facilities such as buildings, utilities, etc.

(4) List of Installations and/or Facilities. On the basis of the scope of construction requirements and the construction standard, a list of installations and facilities (identified by their numbers) can be developed. TM 5-301 is used to select the desired installations and facilities. (See previous example problems for details.)

(5) Installation Layout. TM 5-302 gives the recommended layout of facilities within the installation; however, the recommended layout may need to be revised to meet terrain requirements and other site-specific conditions such as existing buildings, roadways, utilities, and dispersal.

(6) Real Estate Requirements. TM 5-301 gives the quantity of land required for the recommended facility layout. If the recommended layouts are not used, the actual required land area should be calculated based on the revised layout. AFCS installation designs are generally based on minimum real estate requirements.

(7) Construction Effort, Cost, Logistics Data, and BOM. TM 5-301 and TM 5-303 provide the estimated construction man-hours, cost, and logistical data for transportation; TM 5-303 also provides the BOM. The number of man-hours required for all horizontal, vertical, and general construction should be tabulated and compared with the number of man-hours available from construction units in each category. If there are deficiencies, additional man power support should be requested. The total time needed to complete all construction can be estimated on the basis of the available man power and the number of man-hours required for construction.

(8) Project Execution. Project execution ends the planning steps discussed in paragraphs *(1)* through *(7)* above. The working drawings in TM 5-302 provide information of various construction resources (including engineer units and civilian labor) used to execute the project.

e. Example Problem 8.

(1) Problem Statement.

(a) General. A cantonment is required for five companies, or about 1,000 troops. A 55-acre site has been selected and is suitable for construction without major grading and clearance operations. The camp will be located in a temperate zone and will be turned over to allied forces at the end of hostilities; therefore, the temporary standard of construction would be the most suitable.

(b) Water Treatment and Distribution. Potable water is not available from local communities; however, intelligence sources indicate that good well water should be available within 250 feet of the surface. Water storage should be provided for about 40 to 50 percent of the daily demand as called for in the installation description.

(c) Sewage Collection and Treatment. All waste water from the camp must receive primary and secondary treatment before being discharged into any local streams. Local code requirements do not allow pit latrines within the cantonment; therefore, a waterborne sewage treatment facility will be required.

(d) Electrical Power and Distribution. Intelligence shows that the local power generation capacity is insufficient and unreliable. Assume that power genera-

tion with a 30-percent emergency backup capacity will be required.

(e) Recreation and Service Requirements. Assume that a chapel with a capacity of at least 25 percent of the camp's population will be required. No athletic courts or theater are scheduled at this time.

(f) Roads. There is bituminous surfacing on many roads in the vicinity, so no major road-building projects are anticipated. An abundance of good aggregate can be found nearby.

(g) Resources. About 300 civilians will be available for general labor tasks. One line company from a combat engineer battalion (heavy) will be available to work on the project.

(2) Problem Solution. Figure 4-3 shows the procedure for solving this type of problem. The planning, design, and estimation stages explained in paragraphs *(3)* through *(9)* below correlate with parts d(1) through d(7) of figure 4-3.

(3) BDP--d(1). Review the BDP directives and the general problem statement and summarize the basic requirements.

(4) Site Selection--d(2). Since a site has been assigned previously, no action is needed now. Later, it will be necessary to verify that the site is large enough and is suitable for constructing the project.

(5) Scope of Construction--d(3). All construction will be new, since no facilities in the area, except the roads, can fulfill any requirements of the problem statement.

(6) List of Installations and/or Facilities--d(4).

(a) General. The best way to approach the problem is to select from TM 5-301-1 the smallest component that will satisfy the mission requirement. For this problem, the temporary standard has been specified. Begin by scanning the index of the Listing of Installations in TM 5-301-1 and turn to the first page of "Camps, Troop." Note the verbal description of each installation in the upper left-hand corner of the page. Check the listing page-by-page and find a 1,000-man, temporary standard, wood frame troop camp that can be used (such as installation NT1531). To determine the most suitable type of construction (steel or wood frame), consider the following: availability, engineering effort required, timeframe for completion, logistical requirements, and cost.

(b) Choice of Materials. Normally, the most important consideration is the availability of materials. Since wood is usually readily available, NT1531 (wood frame) is probably the best choice, assuming the other constraints listed in *(a)* above are of little consequence. Based on DOD planning factors, the installation requires 25,000 gallons of water per day, generates 17,500 gallons of sewage, requires 52.1 acres of land, and requires at least 485.5 kW of electrical generation capacity.

(c) Chapel. Since the chapel building serves a specific purpose, it is listed in the facilities section. In the index of the Listing of Facilities, find the page number for chapel listings; from that page search page-by-page until a suitable facility is found. Facility number 74018AU, a wood frame chapel with 300 seats, appears to be the best choice, since it is the smallest available facility meeting the basic requirement of seating 25 percent of the camp's population.

(d) Water Treatment Plant. In the index of the Listing of Facilities, find the page number for "Water Supply and Treatment" and search page-by-page for a facility that meets the problem's requirements. Facility 84120AB will supply up to 60,000 gallons of water per day. That facility consists of a deep-well hypochlorination unit with 21,000 gallons of elevated storage, yielding a storage capacity of 84 percent (21,000 gallons storage/25,000 gallons daily demand x 100) of the total daily demand, and thus provides more than the percentage of storage required. However, one of the two 10,500-gallon elevated storage tanks could be deleted from the facility, reducing storage to the required 40 to 50 percent.

(e) Sewage Treatment Plant. Select a sewage treatment plant in the same way a water treatment plant was selected in *(d)* above. Consider plant capacity first. TM 5-301 shows that facility 83110AA can handle 25,000 gallons per day. Since facility 83110AA is the first installation listed exceeding the required 17,500 gallons per day and offering both primary and secondary treatment as required in the construction directive, it appears to be the best choice.

(f) Electric Generating Plant. The electric generating plants are found in the Listing of Facilities of TM 5-301. To determine the capacity of the generators, tabulate the loads of the various components to be ordered and add an additional 30 percent as called for in the construction directive:

Table 4-3. Data for various construction components

	Materials			Construction Effort in Man-Hours			
Facility or Installation	Weight short tons	Volume measured tons	Cost $	Horizontal	Vertical	General	Total
Camp NT1531	3,473	3,234	516,870	5,492	32,172	8,820	46,484
Chapel 74018AU	48	57	8,879	32	1,340	78	1,450
Water Supply 84120AB	21	47	24,204	484	129	220	833
Latrine (Drop) 72312BC	-5	-6	-1,028	0	-112	-16	-128
Sewage Plant 83110AA	140	302	83,420	69	4,533	300	4,902
Generator 81110GA	112	267	198,408	105	3,798	949	4,852
Total	3,789	3,901	830,753	6,182	41,860	10,351	58,393

- Basic camp 485 kW
- Chapel (insignificant)
- Water treatment (insignificant)
- Sewage treatment 25 kW
- Total 510 kW
- Total with 30% backup added 663 kW (minimum)

Find a generator plant of suitable capacity by scanning the various generator and enclosure combinations in TM 5-301 and by consulting drawing 81110GA in TM 5-302 for the schedule of facilities. Facility 81110GA, which has a nominal rating of 1,500 kW, is a suitable choice, since it is the smallest nontactical generator.

(7) Installation Layout--d(5). Consult TM 5-302 for applicable construction drawings of troop camp NT1531. A complete site analysis should be done to ensure a workable final product. Obviously, the water treatment plant must be close to the water supply, and the sewage treatment plant should be situated both downstream and downwind of the camp. The generator building should be located on higher ground in order to avoid the risk of flooding. Other factors, such as site access, security, and solar orientation, should also be considered.

(8) Real Estate Requirements--d(6). The total land area required for the camp can best be determined by adding the various component requirements:

- Basic camp 52.1 acres
- Water treatment 1 acre
- Sewage treatment 1 acre
- Generator and chapel (negligible)
- Total 54.1 acres

Assuming that all parts of the assigned 55-acre site are usable, the land area should be sufficient for the troop cantonment and support facilities. Therefore, the site would be considered suitable, and there would be no need to return to the site selection process.

(9) Construction Effort, Cost, Logistical Data, and BOM--d(7).

(a) By setting up a table of data for the various components, the planner can easily determine the total cost, shipping requirements, and construction effort required for the project (see table 4-3).

(b) Assume that one line company from a combat engineer battalion (heavy) is available to work on the project. TOE 5-118H indicates that the estimated effort available from a combat engineer company (heavy) is 2,877 man-hours of vertical effort, 3,288 man-hours of horizontal effort, and 17,466 man-hours of general effort per company month (CO MO). For this problem, it is assumed that the 17,466 man-hours of general effort will be applied to the vertical effort; therefore, those values are added civilian man-hours available per month and can be calculated as shown in the following equation:

(Civilian Laborers Available) x (Hours/Day) x (Days/Month) = Civilian MH/MO

$$\text{Horizontal Duration} = \frac{\text{MH Required}}{\text{MH Available/CO MO}} = \frac{\text{5,615 MH}}{\text{3,288 MH/CO MO}} = \text{1.71 CO MO}$$

$$\text{Vertical Duration} = \frac{\text{MH Required}}{\text{MH Available/CO MO}} = \frac{\text{70,740 MH}}{\text{20,343 MH/CO MO}} = \text{3.48 CO MO}$$

$$\text{General Labor Duration} = \frac{\text{MH Required}}{\text{MH Available/MO x EFF}} = \frac{\text{20,487 MH}}{(300) \times (12) \times (30) \times (.60)} = \text{0.32 MO}$$

Figure 4-4. Calculations for project duration

(c) Since local labor is likely to be less efficient than troop labor, multiply the civilian man-hours/month by the civilian efficiency in order to compensate. For example, assume 60-percent efficiency:

(Civilian MH/MO) x (.60) = Actual Civilian MH/MO

(d) Assuming the work is done by a combat engineer company (heavy) and 300 civilians, the calculations for project duration would be as indicated in figure 4-4. Those durations do not consider construction sequencing. Chapter 3, which discusses CPM networks, gives a detailed and accurate approach. However, as a rough estimate, the project duration would be determined by the largest of the three values, or about 3.48 company months.