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CONSOLIDATION AND REALIGNMENT OF BASE-LEVEL SUPPORT EQUIPMENT MAINTENANCE

THESIS

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James C. Katrenak

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Abstract

The adoption of the "Objective Wing" organization in the United States Air Force has realigned many base-level maintenance functions. Support equipment is currently maintained and accounted for by several units under the Logistics Group Commander. This research determined the feasibility and consequences of consolidating or realigning maintenance of powered and non-powered AGE, MMHE, engine trailers, and vehicles into one consolidated maintenance shop or unit per base. This study consulted many sources, ranging from occupational survey reports and career field education and training plans to actual field observations of maintenance processes and unstructured interviews of personnel and supervisors. This study determined that maintenance tasks, processes, and required competencies for support equipment maintenance activities within aircraft maintenance are similar. Enough differences in training, maintenance information management systems, and maintenance philosophies exist between vehicle maintenance and AGE to dismiss the consolidation of these areas.

CONSOLIDATION AND REALIGNMENT OF BASE-LEVEL

SUPPORT EQUIPMENT MAINTENANCE

I. Introduction

Chapter Overview

In recognition of the importance of effective and efficient organizational structure, this thesis presents an analysis of options available for the consolidation and realignment of support equipment maintenance at base-level Air Force units. This chapter justifies this analysis by presenting the general status of base-level support equipment maintenance and general issues surrounding Air Force reorganization. The chapter then provides the rationale for consolidation and realignment of base-level support equipment maintenance. The resulting research objective and investigative questions follow. Finally, a summary of the methodology employed (with a description of its scope and limitations) is presented.

General Issue

There is no air power without ground power. The Air Force owns and operates thousands of pieces of powered and non-powered ground support equipment to

accomplish its mission. This equipment includes aerospace ground equipment (AGE), munitions material handling equipment (MMHE), aircraft engine trailers, general purpose vehicles,and special purpose vehicles. Generally, this equipment is maintained in a variety of shops, often by the using function.

Ground Support Equipment. Aerospace ground equipment (AGE) is the general term used for most aircraft ground handling and servicing equipment. Powered AGE includes electrical generators, hydraulic power sources, pneumatic power sources, air conditioning units, auxiliary lights, and air compressors. Aircraft tow bars, maintenance stands, jacking equipment, and utility trailers are examples of non-powered AGE. In the Air Force, AGE is maintained by the aircraft maintenance function at each base.

Munitions material handling equipment (MMHE) is used for the movement, handling, and loading of munitions. This equipment is also either powered or non-powered, and includes munitions trailers, bomb lifts, and Universal Ammunition Loading System (UALS) units. The maintenance of MMHE is the responsibility of the munitions maintenance function.

Aircraft engine trailers facilitate the movement and installation of jet engines. This category of support equipment is maintained by the propulsion maintenance shop on each base. A recent change in the Air Force's jet engine maintenance concept is shifting engine maintenance responsibility to the depot level. In the coming years, many bases

will lose much of their engine maintenance capability, and along with it, the personnel traditionally tasked to maintain engine trailers.

General purpose vehicles and special purpose vehicles are maintained by the transportation function on each base. General purpose vehicles are common, commercially procured vehicles such as sedans, trucks, and buses. Special purpose vehicles are usually used for a unique purpose. This category of vehicles includes forklifts, fire trucks, tow vehicles, bobtails, snow plows, and refueling trucks.

Maintenance Organizational Structure. For many years, the maintenance of this equipment did not fall under the same "chain of command" in a typical Air Force unit. While AGE, MMHE, and engine trailer maintenance were organized under the Deputy Commander for Maintenance (DCM), the Deputy Commander for Resources (DCR) owned the transportation and supply functions (Justice, 1988). Thus, the maintenance of each type of equipment was functionally aligned, with a possible duplication of support equipment maintenance capabilities throughout the Wing.

Beginning in 1991, the reorganization of the Air Force into its "Objective Wing" structure emphasized the streamlining and flattening of organizations in an effort to consolidate resources where practical (Perini, 1992). Logistics functions, to include transportation, supply, and maintenance (except for flight line maintenance), were put under the direction of a Logistics Group Commander (Department of the Air Force, 1991a). The realignment also created a Maintenance Squadron under the Logistics Group, which now encompasses the maintenance of AGE, MMHE, and engine trailers

(along with other functions). However, these functions have remained independent, even though they are located within the same organization (1994a).

Corporate Restructuring. Restructuring in the Air Force follows a trend in the business community. Much of corporate America is currently in the midst of a similar organizational restructuring, characterized by downsizing and reorganization. In the first quarter of 1994, U.S. employers averaged 3,200 layoffs per day (Morave and others, 1994). Competition and a global economy have forced corporate managers to look towards restructuring to improve efficiency. This restructuring is characterized by continuous revision of organizations, procedures, and systems in an attempt to gain a market advantage (Hendricks, 1992). Managers must judge whether the goals and structure of an organization are congruent to determine if restructuring is needed (Drucker, 1990).

Need for Further Change. While organizational change has become commonplace in modern society, most organizations tend to change as little as they must, rather than as much as they should (Kanter and others, 1992). Even with the recent sweeping changes in the organizational structure, the Air Force must continue to search for new and better ways to increase its operational efficiency. "We need to break the Cold War molds of how we do business," professes the Air Force Chief of Staff, General Ronald R. Fogleman (1995). "The Air Force in the 21st century is going to be lean, agile, and higher tech than the one we know today. We are going to need to function in a decentralized manner to keep up with the fast pace of events." This need for further

change in organizational structure is being driven by level reductions in both budgets and personnel.

Air Force budgets have been declining steadily and will continue to decline. The Air Force budget for fiscal year 1995 was 75 billion dollars, 30 percent lower than in 1990 ("The CBO's Air Force," 1995). The budget request for fiscal year 1996 was only 72.9 billion dollars, a real decrease (including inflation) of six percent in one year (Tirpak, 1995). Budgets are expected to gradually fall over the next five years to an average of 68 billion dollars ("The CBO's Air Force," 1995).

Decreasing annual budgets have impacted Air Force personnel budgets. In 1990, personnel budgets totaled 25 billion dollars, but have decreased to 19 billion dollars by 1995, and are expected to decline another 3 billion dollars by 1999 ("The CBO's Air Force," 1995). These declining budgets have triggered a personnel drawdown. As recently as 1986, Air Force personnel numbered over 608,000 (Callender, 1994). When the ultimate drawdown goal of 385,000 is reached in 1997, personnel levels will be at their lowest since the Air Force became an independent service in 1947 (Tirpak, 1995). Air Force Reserve and Air National Guard units will also see reductions amounting to 11,000 personnel over the next five years ("The CBO's Air Force," 1995).

With lower budgets, fewer personnel, and an increase in operational taskings, Air Force units will be expected to do more with less (Callender, 1994). However, many of our organizations and procedures are bound by existing organizational paradigms or traditions. As Peter Drucker notes, many organizational rules or restrictions may result in inefficient application of the work force (1988). Air Force managers must look for

opportunities to consolidate similar functions and eliminate duplicative efforts, even if they cross traditional boundaries.

A new operational concept, called “Lean Logistics," has recently been initiated in the Air Force with the intent of reducing logistics costs while increasing efficiency. To accomplish its objectives, Lean Logistics relies upon the use of simplified processes, improved management, increased flexibility, lower overhead, and reduced infrastructure. Selective reorganization, consolidating similar functions and eliminating duplicative efforts, may be a key path toward meeting the tenets of Lean Logistics.

Research Objective

Support Equipment is currently maintained and accounted for by several different base units under the Logistics Group Commander. This research is designed to determine the feasibility and consequences of consolidating or realigning maintenance of powered and non-powered aerospace ground equipment, munitions trailers, engine trailers, and support vehicles into one consolidated maintenance shop or unit per base. To that end, this research addresses the following investigative questions:

1. Are similar processes and competencies currently used in the different units where support equipment maintenance is accomplished?
2. What alternative organizational structures could be implemented?

What are the advantages and disadvantages of each alternative?

Conduct of Study

As is the case with almost any policy or process improvement research, the current state of affairs must first be determined before improvements can be formulated and examined. With this in mind, the research conducted in this study is conducted in two phases. The first phase consists of a descriptive accounting of the current state of support equipment maintenance organizations, specialties, and processes. This system description is derived from reviews of Air Force publications, occupational survey reports (OSRs), training course documents, observations of support equipment maintenance functions, and unstructured discussions with maintenance personnel and managers. Specific topics of interest include personnel requirements, requisite skills and competencies, maintenance scheduling procedures, mobility taskings, and type of maintenance management information systems currently in use.

The second phase of this research revolves around alternatives suggested by the first phase of this research. Alternatives are subjectively determined based upon commonality of current systems or processes. Using Air Force guidance on manpower requirements, alternative organizational structures are compared. Comparisons rely not solely on manpower savings, but examine factors such as effects on training and mobility. For this study, the 178th Fighter Group (an Air National Guard unit based in Springfield, Ohio) was chosen primarily due to its proximity and organizational structure. Because this unit is similar in organization and mission to many Air Combat Command fighter units, it is believed that any findings may be applicable elsewhere.

Scope and Limitations. In an effort to accomplish this research within the constraints of available time and resources, the following scope and limitations are established:

1. Facilities will not be a consideration, as units would most likely be realigned or consolidated without the addition of new facilities.
2. Total costs for consolidation or realignment options presented will not be calculated.
3. Results obtained cannot be tested without thorough experimentation with an actual restructured unit.

Summary

This chapter established the focus of this research effort. The unstable world environment and shrinking military budget have elevated the importance of effective and efficient organizational structure in the Air Force.

Support equipment maintenance is a vital function in the accomplishment of the Air Force mission. Currently, this type of maintenance is performed by many different organizations at the base level. The recent Objective Wing restructuring has aligned much of this possibly duplicative support equipment maintenance capability under the Logistics Group Commander. Due to ongoing drawdown actions, manpower throughout the Air Force is being reduced, and efficiencies generated through alternative organizational structures should be investigated. This research is intended to investigate

the processes used and types of tasks performed in each organization, alternative organizational structures, and the associated advantages and disadvantages of each.

The chapters that follow describe the shaping of Air Force maintenance organizations and specialties, the methodology used to achieve the research objective, an analysis of current equipment maintenance systems, and finally, the comparison of proposed alternatives derived from this research.

II. Background

Chapter Overview

Before pursuing the research objective of determining the feasibility and consequences of consolidating or realigning maintenance of logistics support equipment into one consolidated maintenance shop or unit per base, a historical perspective and the current state of affairs should both be considered. This chapter addresses past and current Air Force organization of aircraft and support equipment maintenance, introduces the concept of Lean Logistics and its potential effects on organizational structure, and summarizes related research involving the restructuring of logistics functions.

Organizational Structure Evolution

The organizational structures of logistics in Air Force operational wings have been continuously debated and modified. An operational wing in the Air Force is generally the largest unit at any single base, and contains an operations group (along with necessary support activities) with related operational mission activities assigned to it (Department of the Air Force, 1994b). The units comprising the wing perform the primary mission, and are generally capable of self-support in functional areas such as maintenance, munitions, and transportation.

Maintenance organizations in the Air Force have evolved over the years to meet changing mission requirements in both combat and peacetime environments. In this

process, centralized organizational structures were established, later yielding to a more decentralized structure. Currently, Air Force guidance directs the use of decentralized organizational designs that allow lower echelons to achieve objectives without needing continuous control from above (Department of the Air Force, 1993).

Army Air Force Maintenance Organization. At the start of the second World War, aircraft maintenance was organized into four echelons (Rutenberg and Allen, 1985). First echelon maintenance consisted of basic servicing, daily inspection, and minor repairs or adjustments to aircraft and associated support equipment. Tools and equipment for this echelon were minimal, and were expected to be deployable by air. Second echelon maintenance was more extensive, encompassing periodic inspections and simple tasks that required more tools and equipment than did first echelon maintenance. Both first and second echelon maintenance tasks were performed by personnel assigned to operational squadrons, with crew chiefs responsible for individual aircraft.

Sub-depot (third echelon) maintenance is similar to what is now called field level or intermediate level maintenance. The sub-depots were not assigned to the operational units, but rather to the Air Service Command at the theater level. This level of maintenance involved the repair of components removed from aircraft due to malfunctions. Included in this echelon was the maintenance of the support equipment used on the flight line. The extensive array of necessary supplies, tools, and equipment required the use of truck transportation for deployment. Repairs beyond the capabilities of the sub-depots were relegated to the depots (fourth echelon), which included all the necessary capability to completely overhaul or refurbish aircraft or aircraft components.

According to Rutenberg and Allen, two common problems resulted from this arrangement (1985). At the lowest echelons, one organization could be working around the clock while another unit on the same base was underutilized. Also, because the sub-depots reported to a different chain of command, they were often considered to be unresponsive to mission requirements.

Logistical operations based upon continental warfare were also found to be cumbersome when applied to the island-hopping campaign waged against the Japanese. After the deployment of B-29s to the Pacific theater in 1944, General Arnold directed the reorganization of maintenance in XX Bomber Command. The maintenance personnel from the sub-depots and organizational units were grouped together to achieve economies of scale and align all organizational and intermediate level maintenance under the same chain of command. Centralized control was established over functionally-aligned shops supporting all assigned aircraft on any single base. This organizational structure was copied in the XXI Bomber Command, and maintenance support improved with this arrangement (Rutenberg and Allen, 1985).

Early Air Force Maintenance Organization. General Curtis LeMay continued to refine the centralized maintenance organization, and later used his experience with the XXI Bomber Command in creating the centralized maintenance concept of the Strategic Air Command. However, this concept was not adopted Air Force-wide.

At the beginning of the Korean War, several problems surfaced due to maintenance organizational structure (Justice, 1988). Units were organized differently based upon the type of aircraft supported. Also, the fluid nature of the conflict and

constant movement of the front line required fighter and attack units to move frequently. The intermediate level maintenance shops encountered many difficulties functioning in this mobile environment. In addition to these problems, the harsh environment and poor facilities hampered many maintenance activities.

Establishment of intermediate level maintenance support in Japan was an attempt to resolve some of these problems. Once again, the intermediate or field level of repair was geographically separated from the organizational level. Combining the intermediate level maintenance function of two wings in the safety of a rear area site in Japan gave operational units more flexibility and avoided the problems of mobilizing intermediate level capability. These units were designated Rear Echelon Maintenance Combined Operations (REMCO). Centralized control of maintenance activities was maintained in REMCO as a means of resolving schedule and priority conflicts.

Standardization of Maintenance Organizations. In the years following the Korean War, the advances in aircraft technology led to even more complex weapons systems. The concept of a single crew chief capable of maintaining an aircraft was no longer realistic. Specialization of personnel in many newly-created career fields (or Air Force specialties) allowed for the advanced training and development of skills needed in the maintenance of this latest generation of aircraft.

Experiences from Korea and the growing complexity of weapons systems led to the standardization of all Air Force maintenance organizations (Figure 2-1). Air Force Regulation (AFR) 66-1, Maintenance Management Policy, was published in September 1956 as a command option, but later became mandatory Air Force wide in 1958

(Rutenberg and Allen, 1985). This standardized organizational structure established responsibility for maintenance workload prioritization and scheduling in a centralized "job control" staff function. Separate squadrons were established for organizational (OMS), field (FMS), munitions (MMS), and electronic (later changed to avionics--AMS)

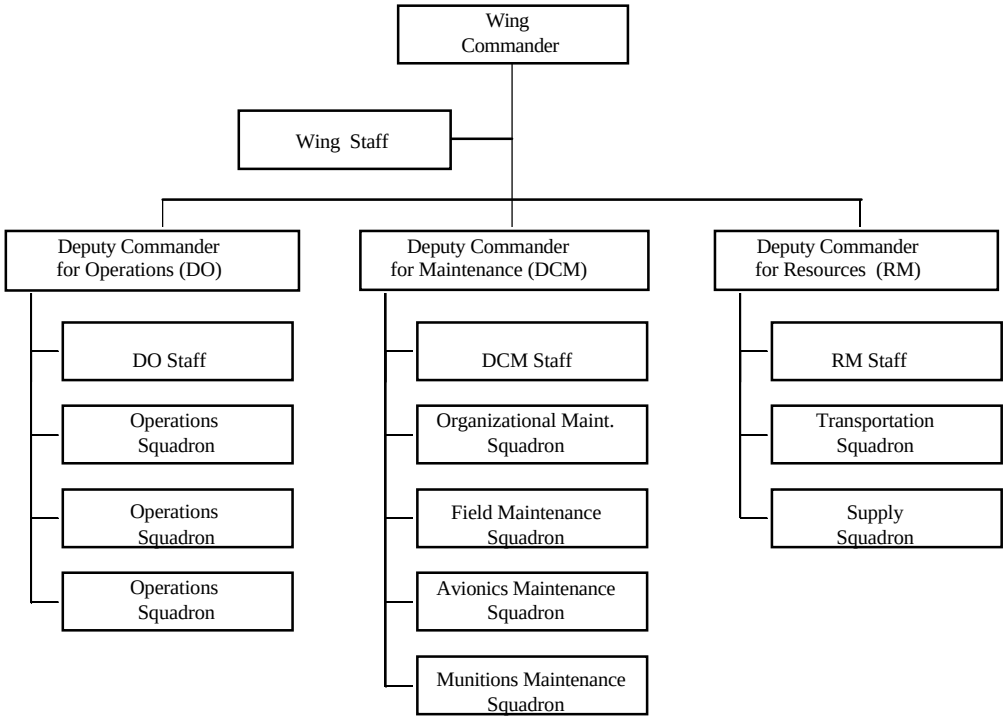

Figure 2-1. AFR 66-1 Organizational Structure

maintenance. Crew chiefs were still used to maintain aircraft, but specialists were dispatched from the back shops for more complex tasks.

The maintenance of flight line support equipment in this organization was divided among many functional areas. The most complex of this equipment was powered

aerospace ground equipment (AGE), which was maintained in the FMS AGE Branch. Maintenance of simpler non-powered equipment was vertically integrated into the using organization. In the Organizational Maintenance Squadron, non-powered AGE was maintained in the Support Branch, aircraft axle jacks were maintained by the wheel and tire shop, and aircraft tripod jacks were maintained by the aero repair shop. Munitions material handling equipment (MMHE) maintenance was accomplished by weapons production specialists in the MMS Munitions Branch. In the FMS propulsion branch, jet engine mechanics maintained engine trailers. This arrangement gave each work center control of its own assets.

Maintenance Organization in Vietnam. Maintenance in the fighter units of the Tactical Air Command (TAC) deployed to Southeast Asia encountered some of the same problems that surfaced in Korea. Large packages of intermediate level equipment and personnel prevented flexibility in the movement of units. Once again, intermediate and organizational level maintenance tasks were separated. Forward operating bases (FOBs) were established with only minimal spares and support equipment. Aircraft were shuttled to main operating bases (MOBs) for more extensive repairs, wasting time and degrading aircraft availability.

To meet tactical mobility requirements, Pacific Air Force (PACAF) units and TAC units in Southeast Asia adopted a different maintenance concept. Organizational Maintenance Squadrons were dissolved and their functions assigned to the operational flying squadrons. Augmented by maintenance and support personnel, the flying squadron gained independent operating capability.

Problems did arise from this new structure. Although maintenance personnel were now assigned to the flying squadrons, the maintenance officer still worked for the chief of maintenance. Also, the chief of maintenance retained responsibility over the planning and scheduling of aircraft inspections, often causing conflicts of priorities. Finally, although maintenance personnel worked for the chief of maintenance, their performance evaluations were written by the flying squadron commander. These inconsistencies led PACAF to abandon this structure in 1966. TAC maintained this structure as an option called the "TAC Enhancement Study." At the end of the Vietnam War, TAC reverted back to the AFR 66-1 centralized structure to benefit from economies of scale and to reduce duplication of efforts among specialists.

Post-Vietnam Maintenance Organization. Although consolidated, centralized maintenance organizations provided greater efficiencies, they still did not meet the needs of the Tactical Air Command. The Vietnam experience demonstrated that deployments of squadron-sized units, not entire wings, would be the expected mode of operation. However, the emphasis of AFR 66-1 was to maximize the maintenance capability of the wing, not the individual squadrons. Different organizational structures (centralized for peacetime, decentralized during deployment) were not the solution--the Air Force needs to train as it fights. An organizational structure was needed to minimize the difference in organization and operating procedures between a peacetime training mode and a deployed combat posture (Hickey, 1970). For this reason, TAC initiated the Production Oriented Maintenance Organization (POMO) in 1975.

Under the POMO concept, aircraft maintenance organizations were once again decentralized. Three new squadrons were created in each flying wing: the Aircraft Generation Squadron (AGS), the Equipment Maintenance Squadron (EMS), and the Component Repair Squadron (CRS). The EMS and CRS provided off-equipment and intermediate level maintenance support. The AGS contained all the flight line maintenance personnel needed for on-equipment maintenance. Both crew chiefs and specialists were assigned to the AGS.

Maintenance support equipment responsibilities remained the same as under centralized maintenance, but were organized under different squadrons. The Equipment Maintenance Squadron contained the AGE Branch and Munitions Branch, where AGE and MMHE maintenance was performed. The Propulsion Branch was assigned to the Component Repair Squadron, retaining maintenance responsibility for engine trailers.

The POMO concept contained three major modifications to the "TAC Enhanced" squadrons of the Vietnam War. Under POMO, centralized control over all maintenance was retained by the chief of maintenance (Deputy Commander for Maintenance, or DCM), minimizing problems with unity of command exhibited in Vietnam. Second, it established maintenance organizations (Aircraft Maintenance Units, or AMUs) within each AGS that were tailored to deploy with a flying squadron. Under this structure, AMU organization was identical in both peacetime and combat situations. Finally, it attempted to offset the traditional organizational inefficiencies of a decentralized organization by consolidating maintenance career fields (called Air Force Specialty Codes, or AFSCs) and cross-training personnel to accomplish tasks outside their specialty. In essence, it reversed the trend of

maintenance technicians training as “specialists” instead of “generalists.” The POMO concept, later to be known as Combat Oriented Maintenance Organization (COMO), was officially recognized by the Air Force in AFR 66-5 as a command option to the AFR 66-1 maintenance concept, and was adopted as the TAC standard by 1979 (Anderton, 1979).

While TAC employed the POMO/COMO concepts, maintenance organizations in the Strategic Air Command (SAC) and Mobility Air Command (MAC) did not quickly stray from the standard AFR 66-1 centralized maintenance concept. These commands owned primarily large aircraft that often contained complex systems, and the utilization of dispatched back shop personnel for flight line on-equipment tasks allowed a maximum number of specialties with a minimum number of personnel. More importantly, while TAC fighters would deploy in complete squadrons, SAC and MAC rarely deployed as squadrons to one location. For this reason, they were already organized in peace as they would be in time of war.

By 1986, some of the advantages of decentralized maintenance control were evident to the Strategic Air Command. SAC implemented its own concept, the Readiness Oriented Logistics System (ROLS), in an effort to achieve greater organizational flexibility while maintaining a clear line of authority and accountability from the DCM (Justice, 1988). Under this concept, specialists were reassigned from FMS and AMS to OMS for on-equipment maintenance, and production control decisions were pushed to the lowest level.

Support equipment maintenance in OMS (non-powered AGE) was shifted to FMS and consolidated into the AGE Branch. The Propulsion Branch lost its flight line

maintenance responsibilities, but retained all its other responsibilities, including maintenance of engine trailers. The Munitions Maintenance Squadron (MMS) was left untouched, and continued to maintain MMHE.

Force Management

The decentralization of maintenance organizations created a need to revise force management policies in aircraft maintenance. Decentralization had created two subsets within many Air Force specialties--specialists to work on-equipment maintenance, and those to work off-equipment maintenance. A leaner, more broadly trained workforce was needed to implement emerging strategies of unit mobility, flexibility, and autonomy. An initiative called "Rivet Workforce" was implemented to restructure maintenance specialties in an effort to overcome the manpower diseconomies produced by decentralized maintenance concepts (Boyle and others, 1985).

Rivet Workforce. Rivet Workforce was a vehicle for initiating and shaping proposals on aircraft maintenance job expansion and evaluating their impacts. Led by the Air Staff, this initiative aimed to combine specialties having underlying similar technologies where prudent, and focus new job classifications on organizational (on-equipment) maintenance tasks (Boyle and others, 1985). Although some off-equipment specialties were reorganized through this initiative, more focus was placed on reducing the "deployable" specialties involved in on-equipment maintenance.

The Rivet Workforce initiatives were devised by a task force comprised of 75 officers and enlisted members, divided into seven working groups. The methods used

involved interviews with job incumbents and subject matter experts in personnel, training, and task analysis. The objective of the working groups was to identify and evaluate alternative ways of reallocating the tasks or jobs of the affected specialties, resulting in various restructuring options to be evaluated.

The initiatives proposed and implemented through Rivet Workforce involved numerous trade-offs in an effort to improve maintenance capability with fewer people. It also identified the idea that barriers to job reallocation are often created as much by factors such as how people are trained, assigned, and used as by aptitude requirements, task training difficulty, and range of tasks to be learned (Boyle and others, 1985). Although this initiative was driven by the decentralization of maintenance organizations, these organizations continued to evolve.

The Objective Wing

In 1992, the Air Force implemented its "Objective Wing" organizational structure that remains intact today (Figure 2-2). The changes implemented were aimed at strengthening the chain of command and accountability for mission accomplishment (Department of the Air Force, 1991a). Using the lessons of POMO and COMO, flight line maintenance was organized to support a squadron of aircraft.. However, instead of merely being functionally aligned with a flying squadron, these personnel now belonged to that squadron, under the authority of the flying squadron commander.

Another purpose of this reorganization was to bring all of the logistical support activities under a single Logistics Group commander (Department of the Air Force,

1991a). With a minimal staff, the Logistics Group commander is responsible for intermediate level maintenance, supply, transportation, and contracting functions. All support equipment maintenance functions (including powered and non-powered AGE, MMHE, engine trailers, and vehicles) are now under the same group commander (Figure 2-3).

The Maintenance Squadron under the Logistics group is composed of elements from the former Field Maintenance Squadron, Avionics Maintenance Squadron, and Munitions Maintenance Squadron. Under the objective wing, all support equipment that

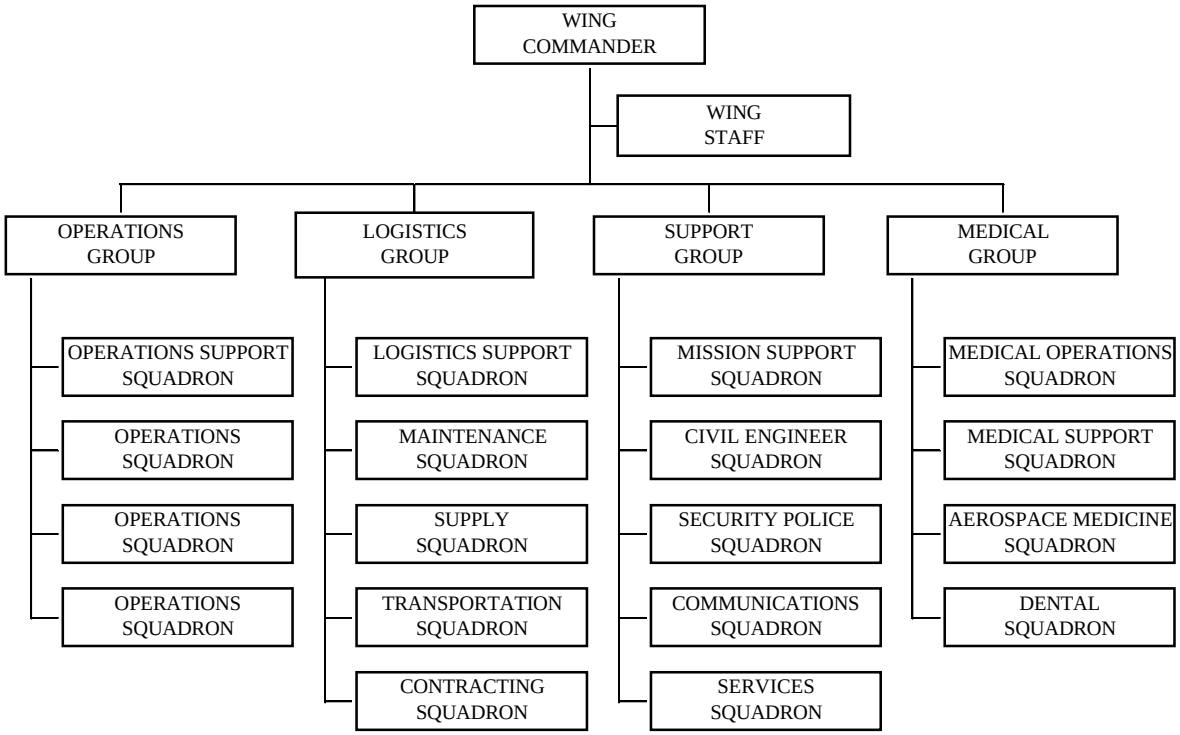

Figure 2-2. Objective Wing Organizational Structure
(Department of the Air Force, 1994b: 10)

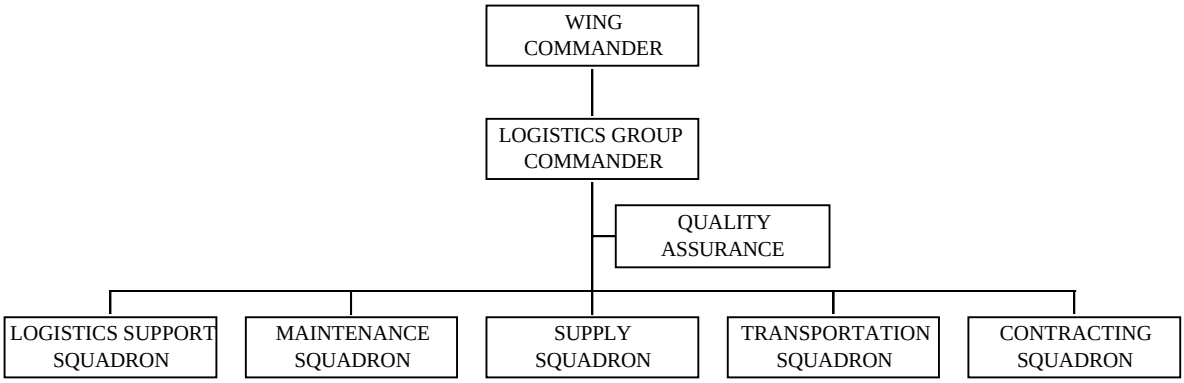

Figure 2-3. Logistics Group Organizational Structure
(Department of the Air Force, 1994b: 11)

directly supports flight line activities (such as AGE, MMHE, and engine trailers) is in the same squadron, but remain in different flights. Maintenance of AGE equipment remains in the AGE flight, engine trailer maintenance remains in the propulsion flight, and MMHE maintenance is in the munitions flight (Figure 2-4).

This restructuring was designed to take advantage of economies of scale, bringing resources under a single commander. Although the Objective Wing implementation is nearly complete, further economies may be realized within the Logistics Group. The Objective Wing reorganized the Operations Group all the way down to the squadron level, but squadron functions within the Logistics Group were not effectively altered (Van House, 1995). The objective wing concept failed to look for consolidation of similar functions and processes in the Logistics Group. This type of analysis can create smaller, more streamlined organizations that are both lean and effective.

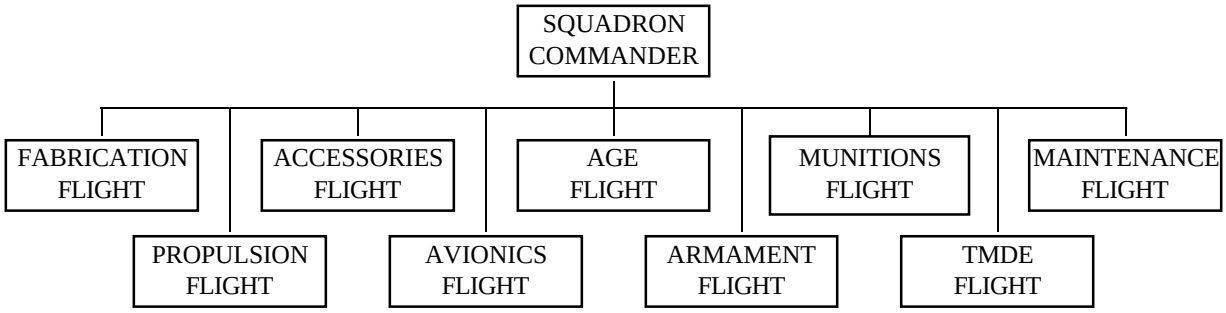

Figure 2-4. Maintenance Squadron Structure
(Department of the Air Force, 1994b: 10)

Lean Logistics

The concept of Lean Logistics is a dramatically new approach to providing logistics support. In response to changing political threats, growing domestic economic concerns, and shrinking military budgets, Lean Logistics aims to replace a decades-old logistics system with one that is state-of-the-art. Its goal is to enhance combat capability while reducing annual operating costs of Air Force systems by adopting commercial business practices, streamlining processes, and reducing infrastructure throughout the Air Force (Morrill, 1995). Selective reorganization, consolidating similar functions and eliminating duplicative efforts may be a key path toward meeting the tenets of Lean Logistics.

The concept of Lean Logistics is based upon commercial practices called "Lean Production" (Girardini and others, 1995). This philosophy was inspired by the need to compete in a dynamic global marketplace where customer requirements and competitive forces are constantly changing. Lean Logistics adopts some of these same business practices to increase flexibility while decreasing costs. Simple, more closely integrated processes are less expensive and require less infrastructure.

Organizational restructuring initiatives will undoubtedly arise due to the embracing of Lean Logistics principles. Eventually, all base-level maintenance processes and functions need to be scrutinized in order to reduce logistics costs. Consolidating similar maintenance functions will allow the Air Force to enjoy the benefits created by even greater economies of scale.

According to former Air Force Chief of Staff, General Merrill McPeak, “We must achieve economies, but we will be very careful here, because consolidation so often goes hand in hand with centralization, which we see as the enemy” (Perini, 1992). Lean Logistics may lead to consolidation or reorganization of some maintenance operations, but centralization should be avoided. Our history teaches us that decentralization, although manpower intensive, is much more amenable to the organization of maintenance.

Previous Research

Previous attempts have been made to suggest non-traditional realignment or consolidation of Air Force base-level logistics organizations or functions. After an exhaustive search, only five studies were found examining the streamlining of support equipment maintenance. While not all focused primarily on base-level consolidation of support equipment maintenance, they offered different approaches with the same goal of greater organizational efficiency.

Cushen and others (1982) examined the possible consolidation of many support operations among various Department of Defense (DoD) installations in Panama. One option in their study focused on the consolidation of vehicle maintenance functions of the Army, Navy, and Air Force units stationed in Panama. Three consolidation options were presented and evaluated using Air Force manpower standards and summaries of work performed. Due to a small personnel savings and inter-service differences in processes, consolidation of this function was not recommended.

Sellers and Harmon (1978) attempted a cost analysis of a base-level consolidated corrosion control work center. They hypothesized that economies of scale could justify consolidation of corrosion control activities of AGE, non-powered AGE, MMHE, and vehicle maintenance. Using manpower standards, data from similar civilian industries, and a model of a consolidated corrosion control facility, they attempted to show a reduction in both man-hours and overhead costs. Primarily due to inconsistent cost data, their results were deemed inconclusive. However, their research suggested reduced man-hour requirements might be realized under the consolidated work center.

In probably the most intriguing research to date in this area, Van House (1995) proposes a new Logistics Group structure. Van House contends that the Logistics Group in the Objective Wing was formed by simply combining intermediate-level maintenance functions with the squadrons previously owned by the Deputy Commander for Resources (DCR). He asserts that the resulting organization could and should be improved upon. Incorporating a successful commercial business practice, general purpose transportation vehicles could be leased, and transportation operations could be contracted. At the same time, maintenance of special purpose vehicles could be allocated to AGE, and vehicle maintenance and vehicle operations flights in transportation could be completely eliminated. With all the changes he proposes for the Logistics Group, Van House contends that managerial overhead could be reduced by forty percent.

Tucker and others (1995) studied the inventory control of MMHE, concentrating their research on munitions trailers. Their aim was to correct deficiencies in munitions equipment management found by a March 1994 Air Force Audit Agency Functional

Management Review. They concluded that by tracking status and configuration in the Core Automated Maintenance System (CAMS), munitions trailers could be monitored in the same manner as AGE. They recommended a study to determine which base maintenance function should be responsible for the maintenance and repair of MMHE. The purpose of such a study would be to determine the practicality of centrally managed equipment maintenance facility within the logistics environment to see if a change would be beneficial to the Air Force.

Beward and others (1996) identified and assessed AGE repair processes at the operational level to determine if opportunities exist for beneficial restructuring using Lean Logistics concepts. Using an extensive literature review, visits to selected AGE operations, and access to maintenance management information systems, they documented both a standardized AGE process and a lack of available data to track these processes. This research suggests that inventory levels of AGE may be too high, resulting in a larger infrastructure and increased costs. Current repair processes are adequate with surplus inventory, but the authors suggest that a "repair on demand" system is better suited to sustaining customer support with a leaner inventory. The quality of data available in current maintenance management information systems was deemed inadequate for quantitative analysis, and recommendations were given for improving this situation. Their final recommendation is to study the possibility of consolidating AGE and vehicle maintenance shops to reduce the number of organizations performing the same or similar functions.

Summary

Although the Air Force has recently completed the most extensive organizational realignment in its history, further changes may still be warranted. Budget and personnel levels will continue to decline, so we must look beyond traditional boundaries in our efforts to make the Air Force lean, agile and more flexible. Further restructuring of base level support equipment maintenance may produce congruence between Air Force goals and structure.

Prior research has investigated consolidation of maintenance on both larger (inter-service) and smaller (corrosion control function) scales. Restructuring of the Logistics Group has been proposed, along with the idea of reassigning some vehicle maintenance functions to the AGE flight. However, the various options available and consequences of consolidating or realigning all of our base-level support equipment maintenance have not, until now, been addressed.

This chapter provided background information needed to understand the importance and relevance of this research. The chapters that follow describe the methodology used to achieve the research objective, the current equipment maintenance systems, and finally, the analysis of proposed alternatives derived from this research.

0147III. Methodology

Chapter Overview

This chapter describes the methodology used to answer the investigative questions presented in Chapter I. The basic issues associated with this thesis will first be reviewed, followed by an introduction of the concept "focused synthesis." Focused synthesis is the methodology used to compile and analyze the material presented in the chapters to follow. After a brief discussion of this technique, the issues to be investigated in each functional area of support equipment maintenance will be introduced.

Background

Lean Logistics is an Air Force program aimed at reducing logistics costs while increasing efficiency through the use of simplified processes, improved management, increased flexibility, lower overhead, and reduced infrastructure. By integrating and applying state-of-the-art business practices across all logistics processes and functions, Lean Logistics promises to provide a logistics system that fully meets mission effectiveness goals, is more responsive to customers, and is cost effective (Department of the Air Force, 1995b). Within the basic tenets of Lean Logistics, this thesis examines the disposition of base-level support equipment maintenance. In an effort to streamline the logistics infrastructure and footprint, maintenance restructuring options will be suggested and analyzed through a comparison of support equipment maintenance functions, competencies, and processes.

Maintenance organizational structures in the Air Force have constantly been evolving since the Second World War. Decentralization of these structures has been the focus, resulting in organizations that are manpower-intensive, with a great deal of specialization. To reduce specialization and reap the benefits provided through economies of scale, many Air Force Specialties were consolidated or realigned in the mid-1980s through the Rivet Workforce program.

The latest organization restructuring in the Air Force, the "Objective Wing," emphasized the streamlining and flattening of organizations to consolidate resources where practical (Perini, 1992). This realignment created a Maintenance Squadron under the Logistics Group, which now encompasses the maintenance of AGE, MMHE, and engine trailers (along with other functions). However, these functions have remained independent, even though they are located within the same organization, and they may be ideal candidates for further streamlining.

With this latest restructuring effort only five years old, the need for further restructuring in the Logistics Group has been recognized. According to Van House, "the Air Force restructure needs to be carried one step further--to restructure to Logistics Group--to be of greatest service to supporting the combat arm" (1995, 30). Recognizing that consolidating or realigning support equipment maintenance functions may provide similar economies of scale as those experienced during Rivet Workforce, the following research objectives will be investigated.

Research Objective

Determine the feasibility and consequences of consolidating or realigning maintenance of powered and non-powered aerospace ground equipment, munitions trailers, engine trailers, and support vehicles into one consolidated maintenance shop or unit per base.

Investigative Questions

1. Are similar processes and competencies currently used in the different units where support equipment maintenance is accomplished?
2. What alternative organizational structures could be implemented?
3. What are the advantages and disadvantages of each alternative?

Methods

As is the case with almost any policy or process improvement research, the current state of affairs must first be determined before improvements can be formulated and examined. With this in mind, the research conducted in this study is conducted in two phases. The first phase consists of a descriptive accounting of the current state of support equipment maintenance organizations and processes. The second phase addresses possible changes to improve the current state and their implications.

Focused Synthesis. The descriptive accounting of the current state of support equipment maintenance organizations and processes is derived in the following chapters through the use of a method known as "focused synthesis":

> Focused synthesis is somewhat akin to traditional literature reviews by involving the selective review of written materials and existing research findings relevant to the particular research questions. However, focused synthesis differs from traditional literature reviews by discussing information obtained from a variety of sources beyond published articles. For example, a typical synthesis might include discussions with experts and stakeholders, congressional hearings, anecdotal stories, personal past experience of the researchers, unpublished documents, staff memoranda, and published materials. (Majchrzak, 1984: 59)

The "focused synthesis" for this research relies on Air Force Instructions, structured and unstructured interviews with maintenance technicians and supervisors, personal experience and background of the researcher, published and unpublished documents and reports, and observations of current processes in support equipment maintenance organizations. Current processes are determined, analyzed, and compared. Prerequisite skills of support equipment maintenance technicians are compared to investigate suitability of consolidating maintenance activities.

Proposing Alternatives. The second phase of this research revolves around alternatives suggested by the first phase of this research. Two prevailing options exist. The first of these alternatives is the realignment of MMHE and engine trailer maintenance under the AGE Flight, aligning all aircraft-related support equipment maintenance in the Maintenance Squadron. This option would shift responsibility for MMHE and engine trailer maintenance to AGE technicians. The second involves the

wholesale consolidation of all logistics support equipment under the Vehicle Maintenance Flight of the Transportation Squadron. This alternative shifts a broad range of responsibilities to the Vehicle Maintenance Flight, increasing the likelihood of realizing economies of scale. At the same time, however, it shifts the maintenance of aircraft support equipment out of the traditional boundaries of aircraft maintenance, which may cause problems in establishing priorities, scheduling maintenance, or tracking maintenance information. These organizational alternatives, along with any others that the first phase of this research may suggest, are analyzed for sources of potential benefits and problems.

Investigative Topics

During the focused synthesis process, each of the areas where support equipment maintenance is currently performed is individually studied to establish the current state of affairs. The following chapters focus on these specialties, concentrating on the tasks performed, skills required, and processes used.

Functional Area Descriptions. The discussion and analysis of each functional area involved in support equipment begins with a description of the organization and career fields of the maintenance personnel. Descriptions found in Air Force Manual 36-2108, *Airman Classification*, were used extensively in establishing this foundation. This information was supplemented by information provided by Air Force Occupational Survey Reports (OSRs).

OSRs are reports written for each career field based upon survey data collected by the USAF Occupational Measurement Squadron (AFOMS) at Randolph Air Force Base, Texas. Beside specialty descriptions, other useful data can be derived from them. Based on survey replies, the career field can be grouped into various "jobs," and the demographics for each of these are presented. The duties of each job are included, and survey results depicting percentage of time expended on each task are given. Individual tasks are rated for difficulty and percentage performing, and these data are used in determining training requirements.

Required Skills and Training. In addition to OSR data, information about the required skills and training needed for each area investigated has been obtained from the training managers of each specialty. Career Field Education and Training Plans (CFETPs) contain the skills required and the career progression flow of the maintenance technicians. Included in the CFETP is the Specialty Training Standard (STS), which outlines the required competencies for each job requirement in the career field.

Along with the CFETPs, data has been gathered from the course documents of the individual technical training courses from each specialty. The course charts furnish a breakdown of course objectives and training times, providing further understanding of the initial skills requirements in each specialty. On-the-job training information was derived from the CFETP and training records (AF Forms 623a and 797) from base-level units. From all of these documents, the training requirements for technicians in each specialty can be analyzed and compared.

Maintenance Processes. The focus for improving the capability and efficiency of any logistics organization needs to be placed on the processes involved. This operations analysis examines processes used in the various support equipment maintenance operations visited. The maintenance processes in each area of support equipment maintenance are documented for comparison.

Maintenance processes can be divided into two categories—preventive maintenance and corrective maintenance. Preventive maintenance includes the scheduled actions accomplished to retain a system at a specified level of performance (Blanchard, 1992). For support equipment, preventive maintenance involves scheduled inspections, servicing, calibration, condition monitoring, corrosion control, and replacement of critical items to prevent impending failure. A typical preventive maintenance flow is shown in Figure 3-1.

Figure 3-1. Preventive Maintenance Cycle (Blanchard, 1992, 49)

Corrective maintenance (Figure 3-2) includes unscheduled actions accomplished to restore a system to a specified level of performance after a failure (Blanchard, 1992). Corrective maintenance requires fault analysis and troubleshooting, repair or replacement of defective components, any required adjustment or alignments, and a functional check

Figure 3-2. Corrective Maintenance Cycle (Blanchard, 1992, 38)

of the repaired equipment. The prioritizing of unscheduled corrective maintenance over preventive maintenance is referred to as "repair on demand," and is more responsive in providing high equipment availability (Department of the Air Force, 1995b).

This operations analysis also examines the current capability of existing support equipment maintenance functions. The type and quantity of support equipment maintained are examined, and factors such as equipment utilization and maintenance downtime are included. An overabundance of this equipment is possible, and low utilization rates or low downtimes may suggest excess of equipment and capability. Reduction of equipment inventories may provide increased responsiveness, lower costs, and increased simplicity.

Mission/Mobility Considerations. Although logistics managers place emphasis on process improvement, the base-level logistician is concerned primarily with mission accomplishment. As a result, any reorganization proposal must address the ability of the unit to meet its mission in times of conflict. Current mobility taskings of support equipment maintenance organizations are a part of the analysis. The mission capability of the unit, to include mobility taskings, cannot be adversely effected by any proposed reorganization.

Summary

This chapter presented the methodology for answering the investigative questions posed in chapter one. The primary method for collecting relevant information for this research, focused synthesis, was introduced and defined. This chapter also explained the investigative topics to be addressed throughout the research process. Using these topics research, focused synthesis, was introduced and defined. This chapter also explained the

as a framework, an operational analysis of each area of support equipment maintenance is conducted in the following chapter.

IV. Findings and Analysis

Chapter Overview

This chapter presents and analyzes the findings of research on the tasks performed, skills required, and processes used in each functional area of support equipment maintenance. These findings are based upon an extensive review of maintenance, personnel, and training directives. Occupational survey reports and training course documents provided information about required skills and competencies for personnel in each functional area. In addition, support equipment maintenance activities of the 178th Fighter Group were observed and documented. This analysis focuses on establishing the current status as a baseline for comparing these areas to determine the feasibility of consolidating or realigning support equipment maintenance functions.

Aerospace Ground Equipment

The Aerospace Ground Equipment (AGE) flight is located in the Maintenance Squadron of the Logistics Group (Figure 4-1). This flight is responsible for scheduled and unscheduled maintenance, troubleshooting, inspection, modification, pickup, delivery, and servicing of both powered and non-powered AGE. Although the size and organization of various AGE flights may differ, five main functions are universal: repair and inspection; servicing, pickup, and delivery; non-powered AGE; AGE support; and AGE scheduling.

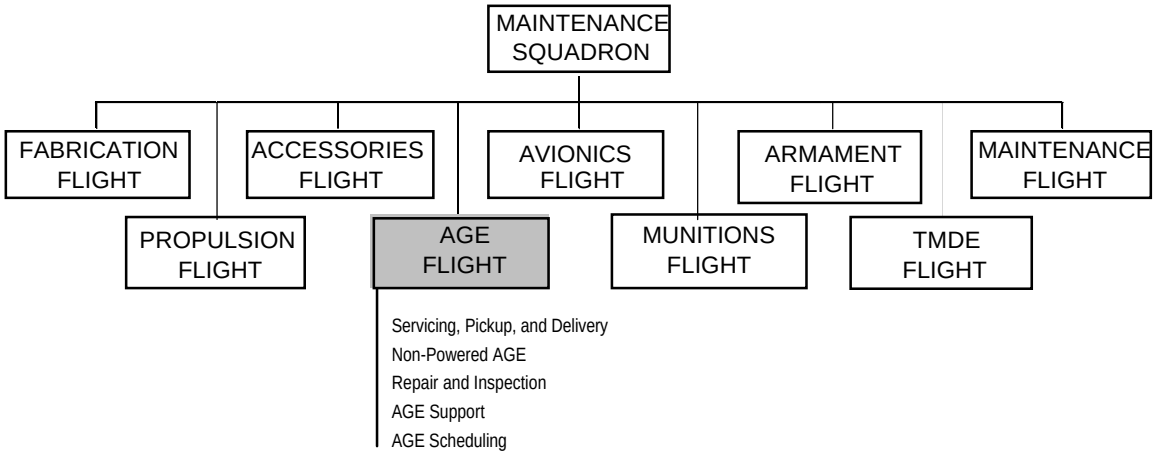

Figure 4-1. Maintenance Squadron--AGE Flight
(Department of the Air Force, 1994b: 10)

The repair and inspection section is responsible for periodic and major maintenance on powered AGE equipment. This equipment consists of electrical generators, frequency converters, gas turbine compressors, air compressors, air conditioners, ground heaters, hydraulic test stands, bomb lifts, and floodlight sets. Preventive maintenance for this equipment is performed based upon a 180-day periodic inspection cycle. Corrective maintenance includes detection, diagnosis, and repair of any malfunctions. The repair and inspection section is responsible for performing corrosion control on this equipment, and they are also tasked to prepare powered AGE for shipment or storage.

The servicing, pickup, and delivery section is the focal point in the AGE flight for meeting the needs of its customers. Personnel in this section are responsible for providing the right type of equipment to the right location whenever it is requested. AGE is either dispatched from the shop, or a "ready line" can be established on the flight line,

stocked with sufficient quantities of serviceable AGE for flight line use. This section performs daily inspections of this equipment, services its fuel and oil, and documents maintenance discrepancies. Units requiring extensive maintenance, either preventive or corrective, are brought to the repair and inspection section.

The non-powered AGE section is similar in function to the repair and inspection section, except that it maintains non-powered equipment. This equipment includes maintenance stands, aircraft jacks, aircraft tow bars, oil and hydraulic dispensing carts, gaseous and liquid oxygen and nitrogen carts, hoists and cranes, and utility trailers. Preventive and corrective maintenance are both performed in this section, and the required periodic inspections of this equipment are also calendar-based.

The remaining two sections, AGE support and AGE scheduling, provide internal support to the flight. The support section maintains and issues AGE tools and bench stock, and provides the flight interface for supply. The scheduling section schedules preventive maintenance, maintains historical records, monitors and reports AGE status, and maintains equipment documentation. Both of these sections may be staffed by personnel from outside the AGE career field.

AGE Career Field. Aerospace Ground Equipment technicians are classified under the 2A6X2 Air Force Specialty Code (AFSC). Personnel assigned to this career field are tasked to maintain AGE equipment to support aircraft systems or subsystems and tactical air control systems (TACS). Duties and responsibilities include planning and

organizing AGE maintenance activities, diagnosing and repairing AGE, and performing scheduled and unscheduled maintenance on AGE.

Personnel in this AFSC follow an orderly skill-level progression. After completion of technical training, new personnel are assigned a 3-skill-level, and perform the most basic tasks. Approximately 13 percent of AGE personnel fall into this group (Department of the Air Force, 1992a). With more training and experience, 5-skill-level personnel have a broader job with increased responsibilities. These technicians make up approximately 54 percent of the career field (Department of the Air Force, 1992a). At the 7-skill-level, the shift from technician to supervisor is clearly evident. Management responsibilities encompass most of the tasks performed by 9-skill-level personnel. Personnel in the 7 and 9-skill-levels comprise 30 and 2 percent (respectively) of this career field (Department of the Air Force, 1992a).

Required Skills and Competencies. An Occupational Survey Report (OSR) was issued in 1992 as part of the Air Force Occupational Analysis Program to determine which tasks are performed by AGE technicians. This survey provides a representation of the type and frequency of tasks performed within each specialty. Representative tasks performed by 3-level and 5-level AGE technicians are shown in Appendix B. This task listing is the foundation of the training needs analysis. A second (separate) survey was administered to experienced technicians in the career field, asking them to rate task difficulty and training emphasis for each item in this task listing. Results of both of these surveys show what competencies are required in the career field, and are the bases for determining training requirements.

Upon completion of these surveys, a Utilization and Training Workshop (U&TW) was held under the direction of the career field manager. The U&TW provided a forum for representatives from each major command (MAJCOM) to provide inputs for changes in the career field description, career progression, and training requirements for personnel in that AFSC. As a result of the U&TW, the Career Field Education and Training Plan (CFETP) was formulated, providing the task and knowledge requirements for each skill level in the AGE career field. These task and knowledge requirements were translated into training requirements for initial skills training of new AGE technicians.

AGE Training. The Aerospace Ground Equipment Apprentice Course is a formal, entry-level training course conducted by the 361st Training Squadron at Sheppard AFB, Texas. All AGE personnel begin their training with this course, and upon completion receive the 2A632 AFSC. This course is considered a Mission Ready Technician (MRT) course, which ensures that the graduates have the necessary knowledge and skills to perform their duties immediately upon graduation

The Aerospace Ground Equipment Apprentice Course provides a foundation of a wide variety of subjects such as safety, security, basic tools, technical orders, and maintenance documentation. Theory of electricity, hydraulics, electric motors, and reciprocating engines are also presented. Finally, the course covers operation, inspection, troubleshooting, and repair of each major type of AGE currently in use. Table 4-1 illustrates the general flow of the major subject areas throughout the course.

Table 4-1. Sequence of AGE MRT Training (Department of the Air Force, 1994c)

Block	Description
I (18 hours)	Security, Safety, Supply, Health and Hazardous Materials
II (34 hours)	Technical Orders, Inspections, Forms and CAMS
III (34 hours)	Basic Electricity
IV (46 hours)	Electrical and Electronic Components
V (56 hours)	Motors and Motor Controls
VI (37.5 hours)	Reciprocating Engines (Part I)
VII (48 hours)	Reciprocating Engines (Part II)
VIII (102 hours)	Gas Turbine Compressors
IX (86 hours)	Diesel Generators and Load Banks
X (61 hours)	Hydraulic Test Stands
XI (61.5 hours)	Bomb lifts
XII (30 hours)	Heaters
XIII (45 hours)	Floodlights
XIV (66.5 hours)	Air Compressors
XV (122.5 hours)	Air Conditioners

Operations Analysis. In an effort to fully comprehend the activities, capabilities, and constraints of AGE maintenance, an operations analysis of the 178th Fighter Group's AGE shop was conducted. This shop employs six full-time technicians to supply the necessary support for twelve F-16 aircraft. These personnel consist of a shop supervisor; one technician for servicing, pick up and delivery; two maintenance technicians; one periodic inspection technician; and a non-powered AGE technician. These personnel are supplemented by eight traditional (part-time) guardsmen for two days every month and one two-week period annually. As in any Air Force maintenance organization, personnel authorizations for this shop are based upon the number of aircraft assigned to the unit.

This shop maintains a total of 130 pieces of powered AGE and 74 pieces of non-powered AGE. Supporting both daily training sorties and a mobility mission, this shop maintains a mission readiness rate consistently over 96 percent for all its assigned AGE, and rarely fails to provide equipment whenever it is needed. Appendix C lists the equipment maintained by this shop, and designates which items are tasked for mobility.

All AGE maintenance discrepancies are tracked in the Core Automated Maintenance System (CAMS). This system can track equipment status, inventory levels, inspections performed, and time change status. It tracks all maintenance actions performed, and provides on-line historical documentation for each piece of equipment. All of this data can be accessed by the MAJCOMs and depots.

Equipment utilization rates are not tracked, but they are quite low. Approximately 70 percent of assigned AGE equipment was observed either on the ready line or in the shop. Closer scrutiny of Appendix C shows that even during mobility situations, only 65 percent of powered AGE and 80 percent of non-powered AGE is tasked. When considered along with the high mission readiness rate, this indicates that the unit may possess more equipment than needed, unnecessarily increasing maintenance workloads.

AGE Maintenance Processes. Using information gathered from observations of operations and unstructured interviews of personnel of the 178th Fighter Group, the basic AGE processes were determined and charted in Figure 4-2 and Figure 4-3. The processes have been categorized as the AGE servicing, pick up, and delivery process and the AGE maintenance process.

Equipment with high utilization is kept on a portion of the aircraft parking ramp designated as the AGE "Ready Line." This equipment is in serviceable condition, and AGE personnel have ensured that it is serviced, inspected, and ready for use. Flight line maintenance personnel needing AGE can retrieve it from the ready line themselves, or call the AGE dispatcher via flight line radio to request it. AGE personnel will deliver the equipment to the needed location, either on the flight line or some other area of the base. In the 178th Fighter Group, the location of each piece of AGE is not tracked through any means.

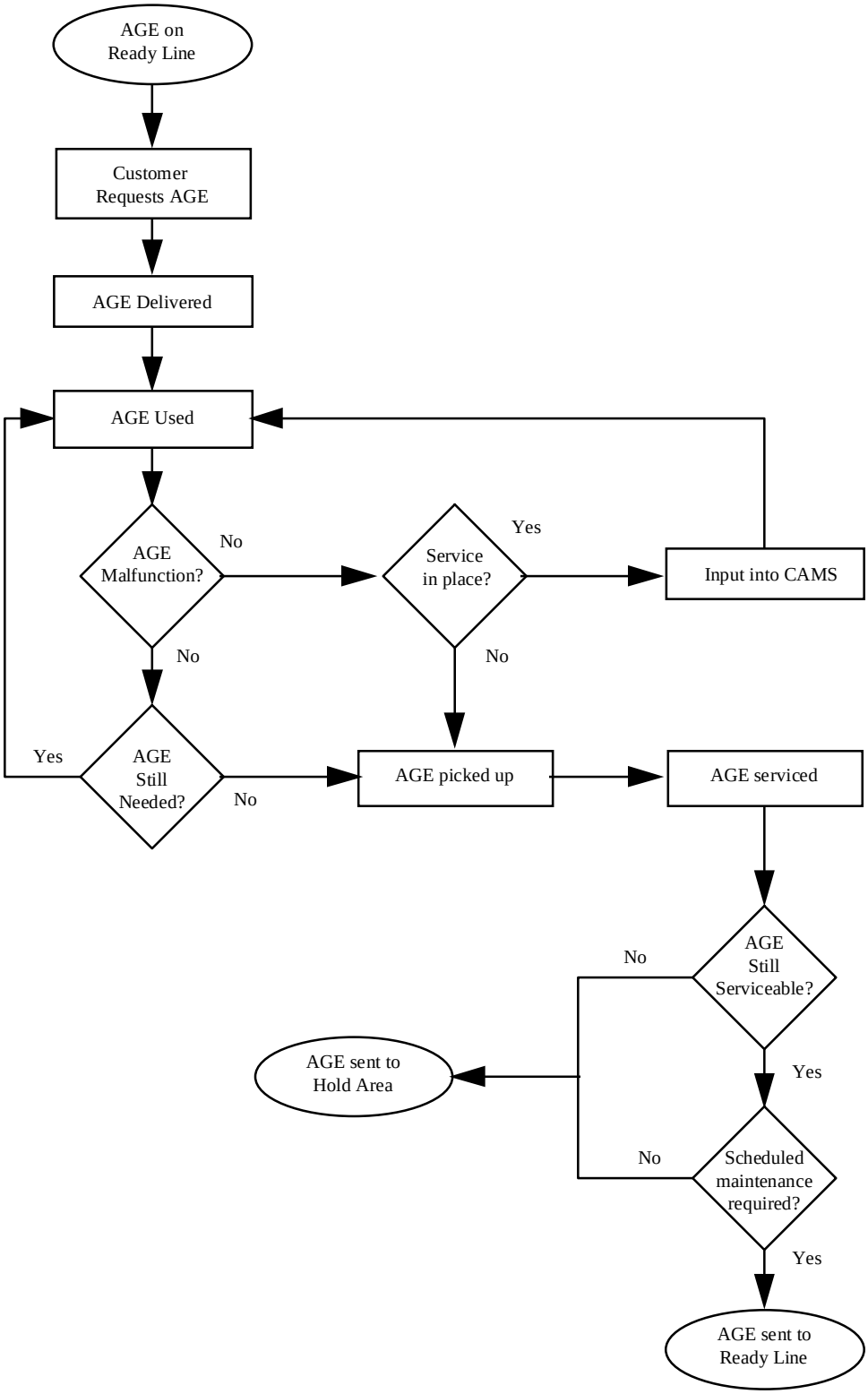

Figure 4-2. AGE Servicing, Pick Up, and Delivery Process

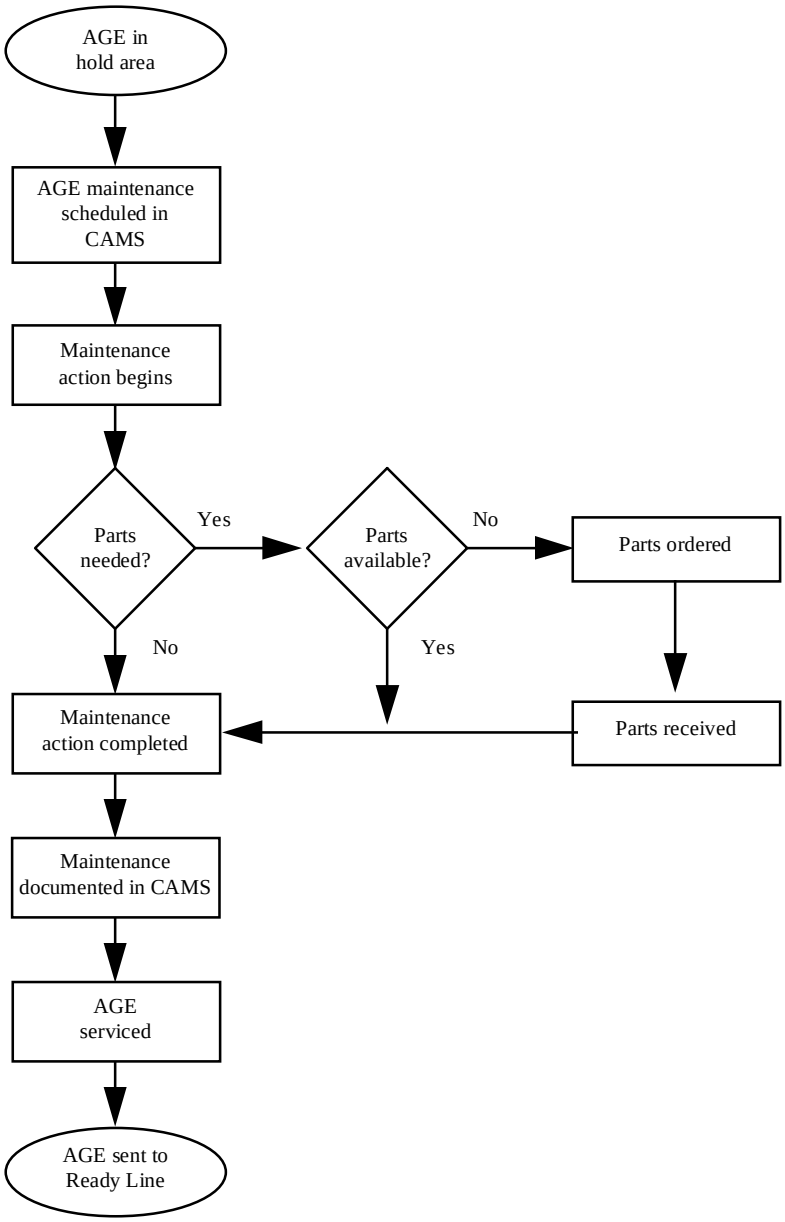

Figure 4-3. AGE Maintenance Process

The AGE is placed in use, remaining there until either it malfunctions or is no longer needed. If the unit malfunctions, AGE personnel attempt to fix the unit in place. If required repairs are more extensive or the unit is no longer needed, it is picked up by the servicing, pick up and delivery section. AGE discrepancies are annotated both on the AFTO Form 244 (Equipment Record) and in the Core Automated Maintenance System (CAMS). Upon pick up, units are serviced (as needed) by AGE personnel before they are placed back on the ready line.

AGE in the hold area remains there until it is scheduled for repair. The scheduling of repair actions is accomplished through CAMS, and corrective maintenance actions are worked into the schedule wherever possible. In some instances, a repair on demand process is used to expedite the repair of equipment that is in short supply.

Throughout the maintenance process, delays may occur due to the unavailability of spare parts. If a part is needed and not on-hand, it is ordered through base supply. If the part is not immediately available from supply, the unit is placed in the hold area until the part is received. Upon receipt of the spare part, the unit must once again be scheduled for maintenance through CAMS.

Upon completion of maintenance, the repair actions are documented in CAMS, and the discrepancy is cleared from the AFTO Form 244. The unit is serviced, and a pre-operations inspection is completed before it can once again be placed on the ready line.

Munitions Material Handling Equipment

Munitions Material Handling Equipment (MMHE) consists of the support equipment used for the movement and loading of munitions. This equipment ranges from simple non-powered trailers to complex powered munitions support equipment. All MMHE, with the exception of bomb lifts, is maintained by the Munitions Support Equipment Maintenance section of the Munitions Flight (Figure 4-4). This flight is responsible for scheduled and unscheduled maintenance, troubleshooting, service inspection, and modification of MMHE. Chassis portions of the Universal Ammunitions Loading System (UALS) are maintained by this section, and they are responsible for the accomplishment and tracking of Time Compliance Technical Orders (TCTOs) performed on all MMHE.

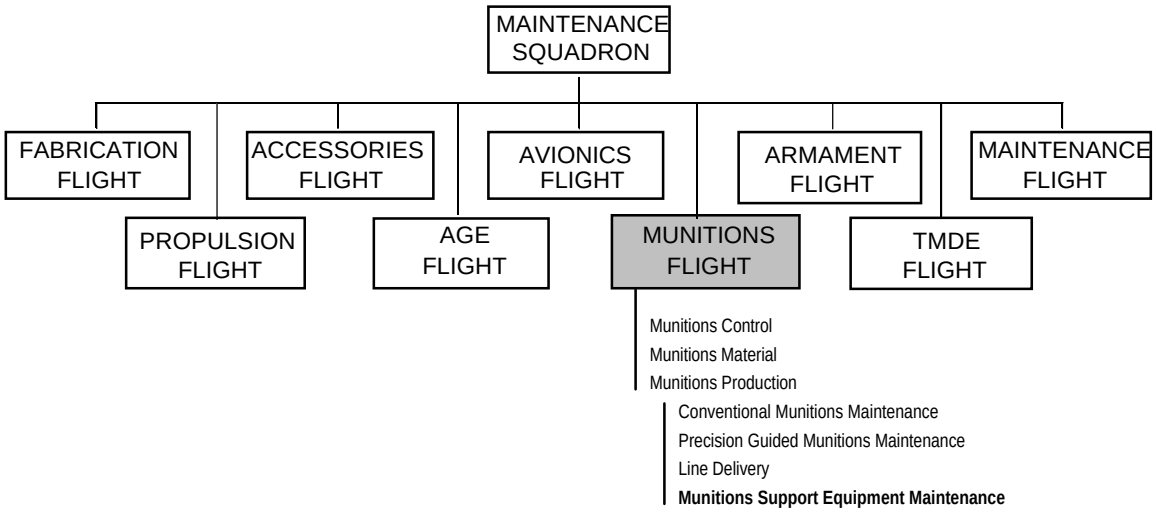

Figure 4-4. Maintenance Squadron--Munitions Flight
(Department of the Air Force, 1994b: 10)

The Munitions Flight is located in the Maintenance Squadron of the Logistics Group. Prior to the adaptation of the "Objective Wing" concept in 1992, the maintenance of AGE and MMHE was accomplished in different squadrons. Due to this reorganization, it may be possible to concentrate all support equipment maintenance, to include MMHE, in the AGE flight.

Munitions Systems Career Field. Technicians in the Munitions Support Equipment Maintenance section are generally classified under the 2W0X1 AFSC. This specialty is primarily concerned with the maintenance and production of munitions, and the maintenance of MMHE is a minor support activity. MMHE is operated in the performance of many tasks in this career field, and its condition is critical to mission accomplishment. This equipment is highly specialized, and is used only by munitions and armament technicians.

Close to five percent of the almost six thousand technicians in this career field are employed in maintaining MMHE (Department of the Air Force, 1990: 14). This job is clearly distinct from others in the career field, as very little of the technicians' efforts are directed toward maintaining munitions. Eighty-four percent of these technicians have either a five or seven skill-level, and with an average of over six years in the career field, this group is also the most experienced of those involved in the storage, handling or maintenance functions of munitions systems (Department of the Air Force, 1990: 15).

Required Skills and Competencies. The latest Occupational Survey Report (OSR) for the munitions systems career field was issued in 1990 by USAF Occupational

Measurement Squadron. This report breaks down the jobs and tasks of technicians in the career field. Representative tasks performed by munitions systems technicians involved in maintaining MMHE are shown in Appendix D. While almost all of these tasks are similar or identical to those reported by AGE technicians in Appendix B, they are markedly different from those reported by the rest of their career field.

One finding of this latest OSR is that the diversity of the munitions systems career field has created problems in providing relevant training. According to Air Force guidelines, tasks performed by less than twenty percent of the career field should not be included in the Specialty Training Standard (STS) portion of the CFETP. The STS elements define the tasks that require training. A large number of unsupported STS elements exist in this career field, possibly resulting in costly over-training of technicians (Department of the Air Force, 1990).

The latest Munitions Systems STS has been pared down to include the tasks most commonly performed. However, this career field continues to maintain a separate Air Force Job Qualification Standards (AFJQS) for different jobs within the career field. This allows requirements for specialty jobs, such as MMHE maintenance, to be standardized.

Munitions Systems Training. The Munitions Systems Apprentice Course is a formal, entry-level training course conducted by the 363rd Training Squadron at Sheppard AFB, Texas. This course satisfies all the knowledge and training requirements

for the award of a 3-skill level. All Munitions Systems personnel begin their training with this course, and upon completion receive the 2W031 AFSC.

The training flow of the Munitions Systems Apprentice Course is depicted in Table 4-2. Due to the broad range of tasks performed in this career field, many different topics are covered. This course devotes a total of twenty-two hours in the instruction of Munitions Handling Equipment in Block II, Storage and Handling (Department of the Air Force, 1995c). However, this time is devoted to instruct students in the use, configuration, and pre-use inspection of this equipment. The tasks involved in preventive

Table 4-2. Sequence of Munitions Systems Apprentice Training Course (Department of the Air Force, 1995c)

Block	Description
I (48 hours)	Munitions Orientation
II (72 hours)	Storage and Handling
III (56 hours)	Maintenance and Assembly
IV (40 hours)	Guided Munitions
V (32 hours)	Introduction to Accounting
VI (32 hours)	Conventional Manual Accounting
VII (32 hours)	NOCM (Nuclear Ordnance Commodity Management) Manual Accounting
VIII (48 hours)	Combat Ammunitions System (CAS) Operations

or corrective maintenance of MMHE are not taught in this course, and any munitions technician working on MMHE must get this training on-the-job (Miller, 1996).

Operations Analysis. The munitions shop of the 178th Fighter Group employs seven full-time technicians to supply the necessary munitions support for twelve F-16 aircraft. All seven technicians are highly skilled and experienced in the maintenance of both munitions and MMHE. One technician is assigned to maintain all of the unit's MMHE, and this duty is rotated on an annual basis. These personnel are supplemented by twenty-nine traditional (part-time) guardsmen for two days every month and one two-week period annually. Two of these technicians are assigned to equipment maintenance. As in the AGE shop, these personnel authorizations are based upon the number of aircraft assigned to the unit.

Although it owns only eleven munitions trailers, this shop maintains a total of thirty-nine pieces of non-powered MMHE. Twenty-five of these units belong to the weapons loaders, and three belong to the Electronic Countermeasures (ECM) shop. Three types of equipment are in the unit's inventory: fifteen MHU-110/M trailers, nineteen MHU-141/M trailers, and five UALS (Universal Ammunitions Loading System) units. Supporting both daily training sorties and a mobility mission, this shop maintains a mission readiness rate approaching 100 percent and rarely fails to provide equipment whenever it is needed.

All MMHE maintenance discrepancies are now tracked in the Core Automated Maintenance System (CAMS). This system has been used in tracking MMHE only since

1995, and this change in policy allows depots to track the equipment. Just as with AGE, this system tracks MMHE status, inventory levels, inspections performed, and time change status. In addition, equipment status is still tracked on a locally developed data base that was in use before the use of CAMS became mandatory.

The 178th Fighter Group also possesses powered MMHE--twelve MJ-1B and eight MHU-83 bomb lifts. Bomb lifts are maintained by the AGE shop, and the necessary tasks are included in AGE training. In addition, it should be noted that almost two percent of all AGE personnel are employed in maintaining other types of powered MMHE (Department of the Air Force, 1992a). In many units, as in the one studied, the AGE shop is also responsible for corrosion control and painting of all MMHE.

Utilization rates for MMHE are not tracked, but they are quite low. Only six trailers and one UALS unit are in use at any one time, and the others are kept in storage. When a corrective or preventive maintenance is required on a unit in use, it is replaced by a unit that is in storage. If this apparent surplus of trailers is not needed for wartime surges, the unit may possess more equipment than needed, unnecessarily increasing maintenance workloads.

MMHE Maintenance Process. The basic maintenance process for MMHE is similar to the one observed for AGE. This process has been charted in Figure 4-5. One minor difference exists between the process observed in the maintenance of AGE and MMHE. While AGE is serviced and dispatched, MMHE in use is in the constant possession of its users.

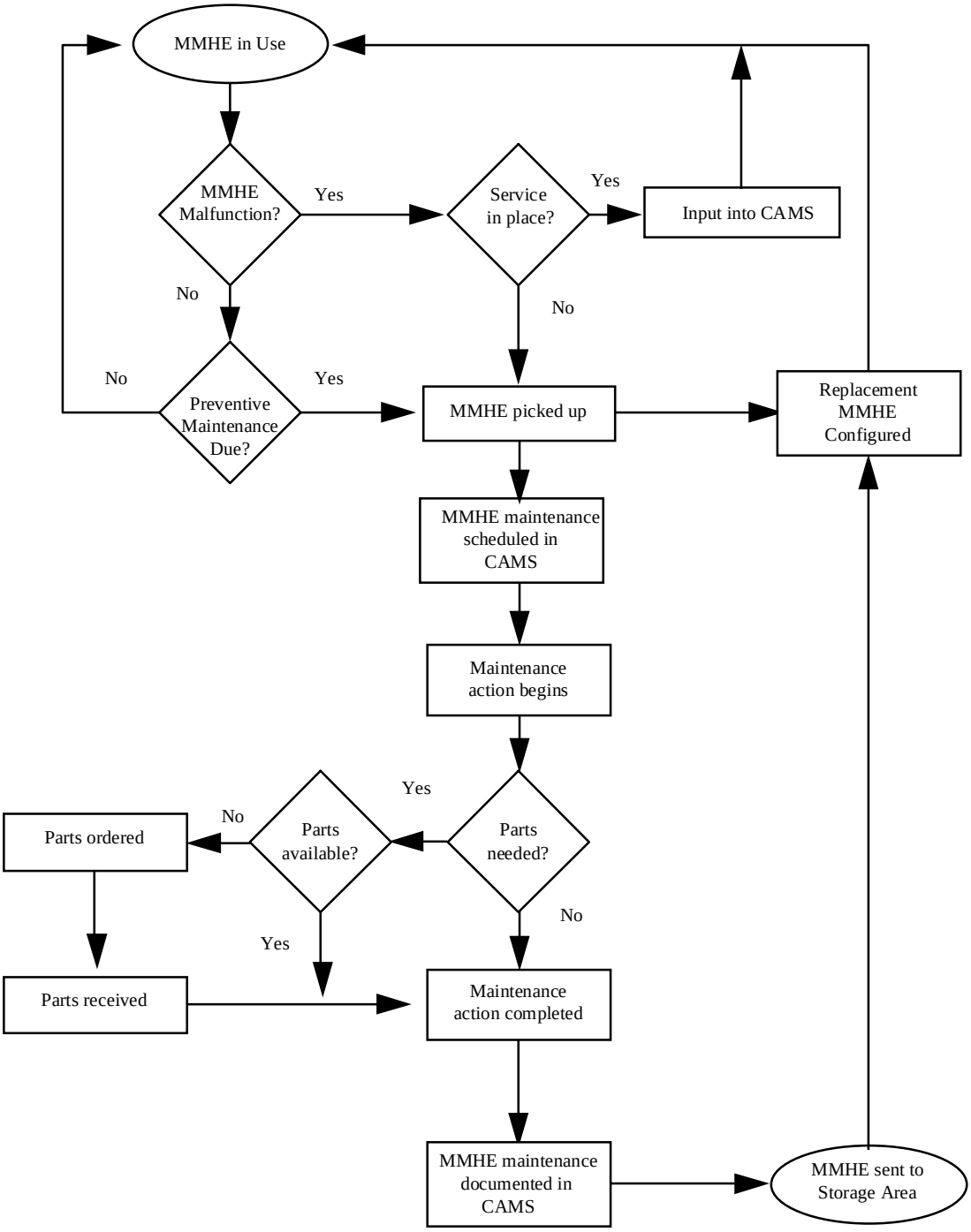

Figure 4-5. MMHE Maintenance Process

Equipment in use remains in use until either preventive or corrective maintenance is needed. The Munitions Support Equipment Maintenance section tracks preventive maintenance requirements, and it notifies the shop where the equipment is in use when maintenance is required. If corrective maintenance is needed, the Munitions Support Equipment Maintenance section is contacted. As stated earlier, a unit picked up for maintenance is replaced by a serviceable unit from storage, and it is configured as needed. Units from storage are selected based upon how much time remains before preventive maintenance is due. Recently maintained MMHE is put back into use quickly, as it has the most time remaining before its next required inspection.

As with AGE, discrepancies with the unit are annotated both on the AFTO Form 244 (Equipment Record) and in CAMS. The scheduling of repair actions is accomplished through CAMS, and corrective maintenance actions are worked into the schedule immediately. Unless parts are backordered or extensive maintenance is required, the shop works on a "repair on demand" policy. Units are upgraded to mission capable status as quickly as possible. Upon completion of maintenance, the repair actions are documented in CAMS, and the discrepancy is cleared from the AFTO Form 244. The unit is placed into storage until needed.

Aerospace Propulsion Non-Powered AGE (Engine Trailers)

Aerospace propulsion non-powered AGE consists of the engine trailers used in the removal, transportation, and installation of aircraft jet engines. This equipment is similar in appearance and construction to other support equipment used in the

maintenance complex. These trailers are maintained by the Non-Powered Support Equipment Section of the Propulsion Flight (Figure 4-6). This section is responsible for scheduled and unscheduled maintenance, troubleshooting, service inspection, and modification of this equipment.

The maintenance of this support equipment is only a minor support element for the primary responsibility of the propulsion flight. The remainder of the flight is organized into sections for jet engine intermediate maintenance (JEIM), test cell and noise suppression systems (NSS), accessory/modular repair, small gas turbine, turboprop/ turboshaft and support, as required. This flight is responsible for off-equipment corrective and preventive maintenance of propulsion units, propulsion components, and propellers.

Aerospace Propulsion Career Field. Aerospace Propulsion Technicians assigned to the maintenance of engine trailers are classified under the 2A6X1 AFSC.

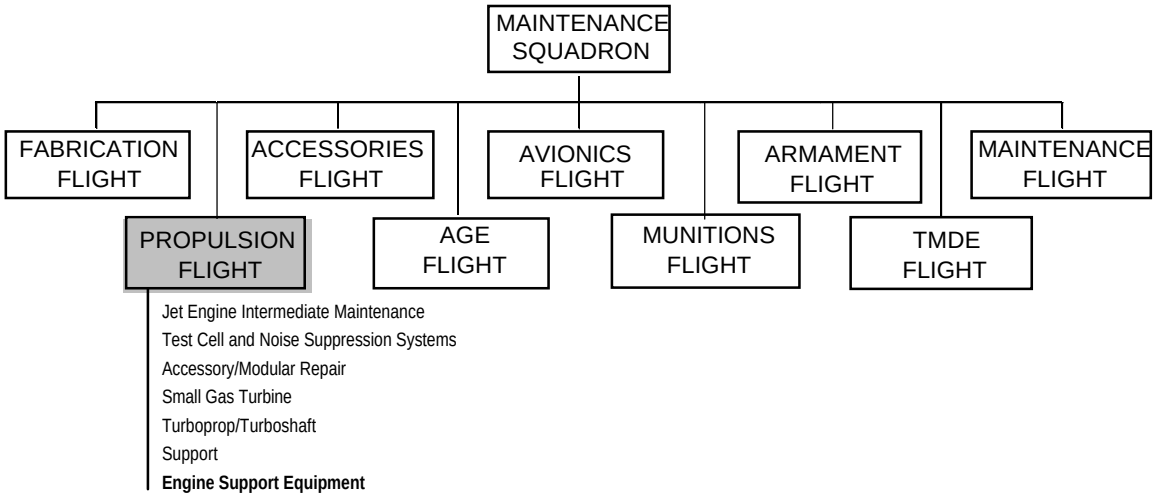

Figure 4-6. Maintenance Squadron--Propulsion Flight
(Department of the Air Force, 1994b: 10)

Additional shreds of the AFSC identify technicians by the type of engine they are qualified to work. This specialty is primarily concerned with the maintenance of jet engines, and the maintenance of support equipment is a minor support activity. This equipment is required for the removal and installation of engines into aircraft, and is used only by aerospace propulsion technicians.

Approximately three percent of the almost ten thousand technicians in this career field are employed in maintaining engine trailers, spending an average of thirty-seven percent of their time on these tasks (Department of the Air Force, 1989: 11). Many of these personnel also perform duties in other areas of the propulsion shop. Eighty-nine percent of these technicians have either a five or seven skill-level. With an average of almost seven years in the career field, this group is more experienced than technicians employed in the buildup and teardown servicing of jet engines in the propulsion shop (Department of the Air Force, 1989).

Required Skills and Competencies. The latest OSR for the aerospace propulsion career field was issued in 1989 by USAF Occupational Measurement Squadron. This report breaks down the jobs and tasks of technicians in the career field. Representative tasks performed by aerospace propulsion technicians involved in maintaining non-powered support equipment are shown in Appendix E. While almost all of these tasks are similar or identical to those reported by AGE technicians in (Appendix B) and MMHE technicians (in Appendix D), they are notably different from those reported by the rest of their career field.

The latest OSR for this career field also measured job satisfaction of the incumbents. Twenty-one percent of the technicians in this career field engaged in maintenance of non-powered support equipment rated their job as "dull," more than double of the response of most other job categories. In addition, thirty-six percent felt that their talents were underutilized, and forty-three percent perceived little or no use of their training. The low level of job satisfaction measured in non-powered support equipment may be the result of this perceived low utilization of talent and training.

Required skills and knowledge are documented in the STS portion of the Aerospace Propulsion CFETP. Tasks performed by non-powered AGE technicians (annotated in Appendix E) are not included in the requirements of this career field. The operation and use of this equipment are required task items for three-level technicians, but maintenance tasks are ignored.

Aerospace Propulsion Training. Initial training for aerospace propulsion technicians begins with a series of courses conducted by the 361st Training Squadron at Sheppard AFB, Texas. All propulsion specialists attend the Aerospace Propulsion Fundamentals Course, which teaches basic concepts needed to work on any type of propulsion system. Following the completion of this course, most graduates continue into an Aerospace Propulsion Apprentice Course. These courses provide specialized training for either the TF-33, F-100, F-110 or T-56 engine. These apprentice courses are Mission-Ready Technician (MRT) courses, satisfying all the knowledge and training

requirements for the award of a 3-skill level. Technicians assigned to other types of engines must attend a Field Training Detachment (FTD) course for system familiarity.

The typical training flow of an F-16 propulsion specialist is depicted in Table 4-3. Students complete the fundamentals course before beginning the apprentice course. The emphasis of both courses is jet engine maintenance, and no time is spent in training technicians to maintain engine support equipment. The tasks involved in preventive or corrective maintenance of engine trailers are not taught in this course, and technicians maintaining this equipment must get their training on-the-job.

Table 4-3. Sequence of F-16 Propulsion Specialist Training
(Department of the Air Force, 1995d/e)

Block	Description
Fundamentals Course (80 hours)	
I (80 hours)	Fundamentals--tools, safety, jet engine operating principles, supply responsibility, deficiency reporting, Quality Air Force, Technical Order system, CAMS,
F-100 Apprentice Course (440 hours)	
I (120 hours)	F-100 Introduction--features, system knowledge, engine inspection and preventive maintenance, engine preservation and storage, technical publications, system removal, system installation, compressor maintenance
II (120 hours)	F-100 Systems--constructional features, technical publications, engine rigging, preliminary maintenance, gearbox and accessories, accessories
III (81.5 hours)	F-100 Internal Maintenance--horizontal engine disassembly and assembly
IV (118.5 hours)	F-100 Engine Removal/Installation--augmentor maintenance, modular maintenance, remove/install airframe mounted engine

Operations Analysis. The Propulsion shop of the 178th Fighter Group employs fourteen full-time technicians to supply the necessary engine maintenance support for twelve F-16 aircraft. Only one technician is involved in maintaining the shop's engine trailers, and he has had this duty for over fourteen years. On a rotational basis, traditional (part-time) guardsmen have also been trained in these tasks. Personnel assigned to engine trailer maintenance also perform other duties, spending approximately one-third of their efforts on trailers.

This shop maintains currently maintains a total of eighteen engine trailers, five more than it is authorized. The shop plans to turn in these excess trailers. Of these eighteen, four are owned by the depot, and these are used to transport engines to and from the depot. Even though they do not own these four trailers, they still must be maintained by this shop. Personnel in this shop seem frustrated over the condition of trailers arriving from the depot.

The shop maintains a mission ready rate approaching 100 percent for its engine trailers. A "repair on demand" process is used, and corrective maintenance is accomplished as soon as possible. Only about six trailers are in use at any one time, and the remainder are kept in storage. Shop personnel did not know why the unit possessed so many trailers, and agreed that their inventory was well beyond requirements. It was also mentioned that the shop possessed only six trailers before the unit's conversion from A-7D aircraft to the F-16.

Maintenance documentation on engine trailers was identical to that found in both the AGE and MMHE shops. Maintenance actions are tracked in CAMS, and an AFTO Form 244 is kept on each piece of equipment. In addition to documenting corrective maintenance actions, CAMS is also used to schedule the accomplishment of TCTOs and preventive maintenance.

This unit still performs intermediate level maintenance on its engines. One of the initiatives of Lean Logistics converts engine maintenance to a two-level (flight line and depot) operation. If this engine is selected for two-level maintenance, many of the functions of the propulsion shop will no longer exist. Engine trailer utilization would increase, as engines would require more frequent depot maintenance. Maintenance of engine trailers would still be accomplished at the unit level--one of the few remaining functions of this shop.

Engine Trailer Maintenance Process. The basic maintenance process for engine trailers is almost identical to that observed for MMHE. This process has been charted in Figure 4-7. One minor difference exists between the process observed in the maintenance of AGE and MMHE. While AGE is serviced and dispatched, MMHE is in the constant possession of its users.

Equipment in use remains in use or in storage until either preventive or corrective maintenance is needed. The non-powered AGE section tracks both preventive and corrective maintenance requirements. If the trailer is loaded with a jet engine, the engine

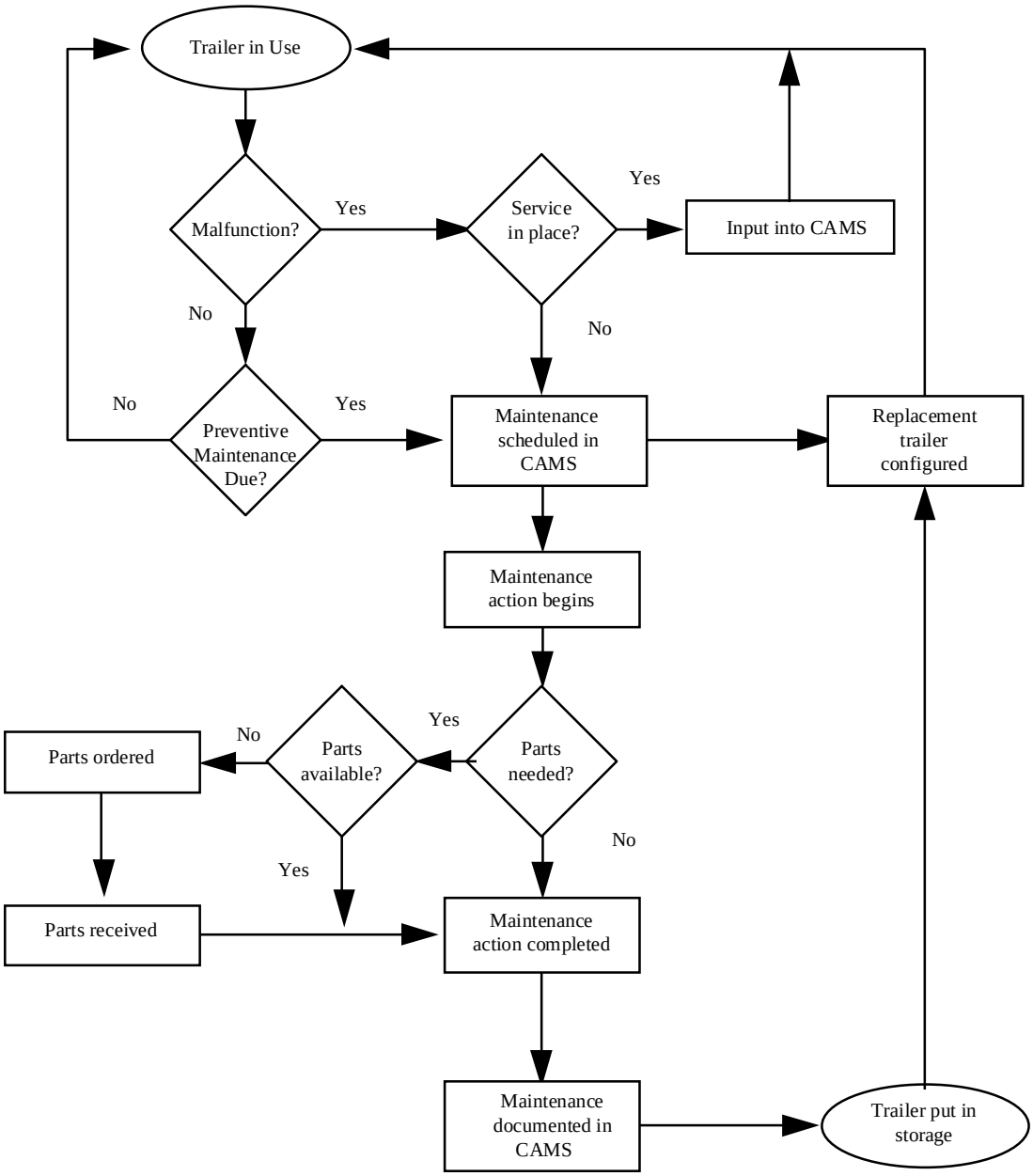

Figure 4-7. Engine Trailer Maintenance Process

is transferred to a properly configured trailer. The section ensures that the trailer selected is serviceable, and will not require preventive maintenance in the short term.

If an engine will be transported to depot, the non-powered AGE section ensures that it is transferred to a trailer owned by the depot. In contrast to the trailer selection described earlier, a serviceable depot-owned trailer closest to its next preventive maintenance is chosen. Through this selection process, the preventive maintenance workload on the section is reduced.

As with AGE and MMHE, scheduling of repair actions is accomplished through CAMS. Any discrepancies with the unit are annotated both on the AFTO Form 244 (Equipment Record) and in CAMS, and corrective maintenance actions are worked into the schedule immediately. The shop works on a "repair on demand" policy (unless parts are backordered or extensive maintenance is required) upgrading the trailers to mission capable status as quickly as possible. Upon completion of maintenance, repair actions are documented in CAMS, and the discrepancy is cleared from the AFTO Form 244. The unit is placed into storage until needed.

Vehicle Maintenance

On any installation, the Transportation Squadron (Figure 4-8) is responsible for the management and control of Air Force vehicles, licensing of operators, and provision of transportation services. The squadron is divided into four flights--Vehicle Operations, Vehicle Maintenance, Traffic Management, and Combat Readiness and Resources.

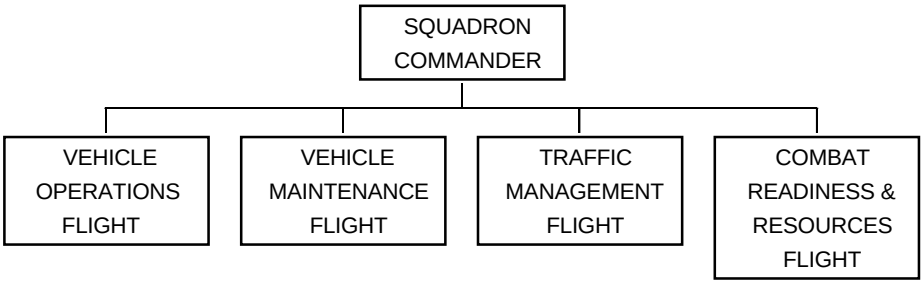

Figure 4-8. Transportation Squadron Structure.

The Vehicle Maintenance Flight (Figure 4-9) is responsible for the management of the installation's vehicle fleet (Appendix G). This flight is composed of many work centers, and oversight of its operations is the responsibility of the Vehicle Maintenance Manager (VMM). Organization of this flight is based upon mission needs and equipment maintained. The Customer Service Center (CSC) is the focal point for customer interface, including the debriefing of vehicle discrepancies and determination of repair requirements. Material control provides an interface between vehicle maintenance activities and the supply system. Maintenance Control and Analysis (MCA) plans, schedules, monitors, and analyzes the maintenance requirements on vehicles, and is responsible for the On-Line Vehicle Information Management System (OLVIMS).

Maintenance of vehicles is divided between two work centers. Common types of vehicles, such as cars, vans, trucks and buses, are classified as general purpose vehicles, and are maintained by general purpose vehicle mechanics. Included in this work center are vehicle body mechanics, who repair and paint damaged vehicle body work. Vehicles

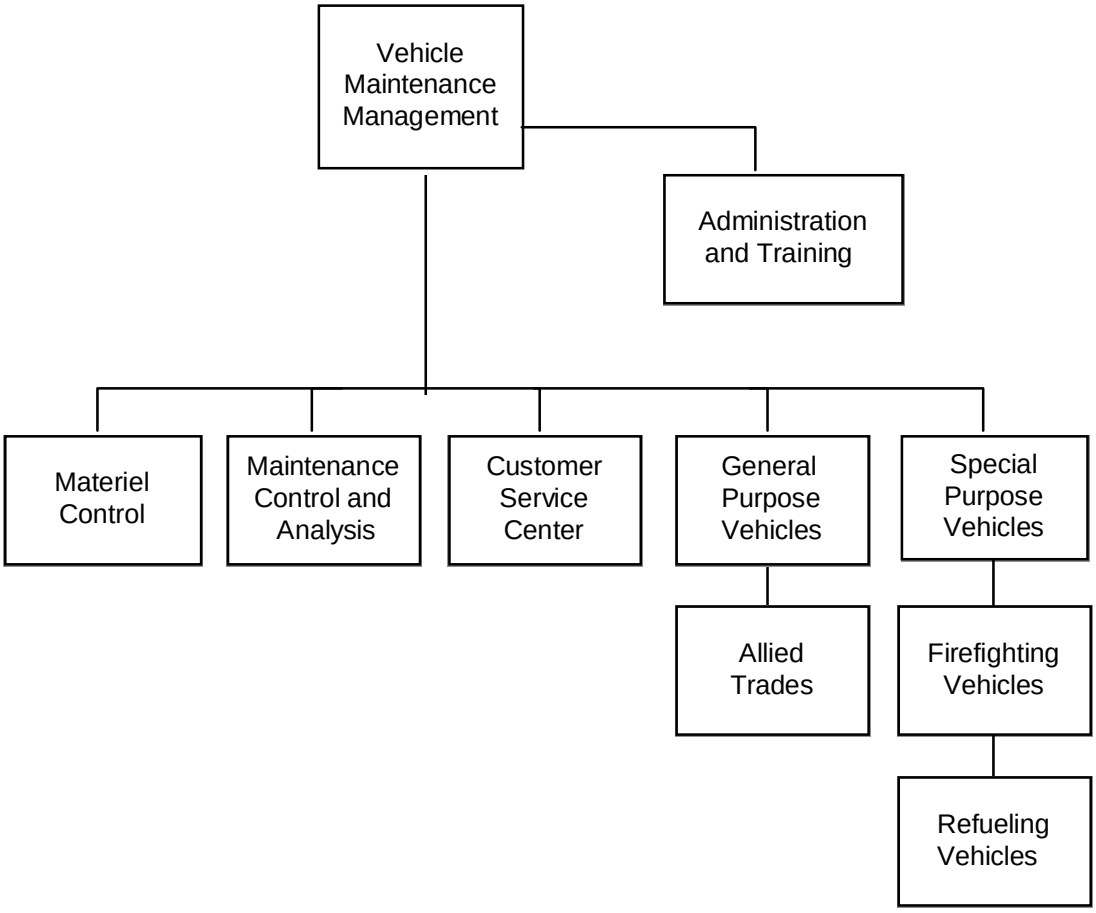

Figure 4-9. Vehicle Maintenance Flight Organization.

and equipment that are highly specialized, such as aircraft tow vehicles, construction equipment, fire trucks, and refueling trucks are classified as special purpose vehicles, and these are maintained by a different group of mechanics.

The maintenance responsibility of the Transportation Squadron is limited to all vehicles purchased with appropriated funds (bearing USAF registration numbers) and selected non-registered vehicles and equipment with a purchase price in excess of $10,000. Unlike the other types of support equipment already studied, the using unit is responsible for organizational level maintenance and servicing of vehicles. The vehicle

maintenance flight is responsible for more extensive repair work, but only within established monetary limits.

Vehicle Maintenance Career Field. Vehicle maintenance technicians are currently organized into five separate AFSCs. General purpose vehicle maintenance technicians (AFSC 2T4X1) repair mechanical, electrical, and hydraulic systems of general purpose vehicles, and account for thirty-six percent of this career field's technicians (Department of the Air Force, 1992b). Special purpose vehicle and equipment maintenance technicians (AFSC 2T3X0) repair the same types of systems on special purpose vehicles. This group contains approximately forty percent of all vehicle maintenance technicians. Special purpose vehicle maintenance technicians specializing in crash and fire vehicle are designated under the AFSC of 2T3X2A, and refueling vehicle specialists are assigned the 2T3X2B AFSC. These groups make up seven and eight percent of the career field, respectively. Finally, vehicle body maintenance technicians (AFSC 2T4X2) repair, refinish, fabricate and rebuild vehicle body parts and panels, and account for eight percent of the career field's technicians.

Required Skills and Competencies. The Air Force Occupational Measurement Squadron issued the latest Occupational Survey Report (OSR) for the vehicle maintenance career ladder in December 1996. Appendix F shows the representative tasks performed by technicians in this career ladder. This OSR demonstrated that a large number of common tasks are performed by these technicians

(except vehicle body maintenance), and suggests a merger of the four common specialties.

Based upon this recommendation, changes in the Specialty Training Standard (STS) have been made (Hoffman, 1996). A common STS has been developed for all four specialties, with mandatory "core" tasks for all personnel. Additional tasks that distinguish one job from another are also included in the STS, and these will be annotated in training records as required.

Vehicle Maintenance Training. Initial training for all vehicle maintenance technicians is currently conducted by the 345th Training Squadron at Lackland AFB, Texas. Five separate courses exist for the five different vehicle maintenance specialties. These courses, however, are due to be replaced in September 1996.

Vehicle maintenance training was an area chosen for revision by the Interservice Training Review Organization (ITRO) in 1994. Under the proposed format, interservice training will be conducted for vehicle maintenance technicians from both the Air Force and the Navy. This training will be located at the Naval Construction Training Center, Port Hueneme, California. Training will begin with a "common core" course (Table 4-4) for all trainees, and follow-on courses will be conducted by the Air Force for service-specific tasks and equipment. Students complete the common core course before beginning the Air Force-unique upper block course (Table 4-5).

Table 4-4. Sequence of Vehicle Maintenance Apprentice Training
(Department of the Navy, 1994)

Topic No.	Description
1 (27 hours)	Tools, shop safety, internal combustion and lubrication systems
2 (30 hours)	Internal combustion engines, tune-up and isolation of malfunctions
3 (63 hours)	Electrical/electronic principles, batteries, solenoids, starting system, charging system, lighting and warning system, airbags
4 (44 hours)	Electronic ignition, fuel and emission system, on-board computer system
5 (17 hours)	Heating and air conditioning
6 (16 hours)	Hydraulic system
7 (27 hours)	Suspension system, steering system
8 (51 hours)	Clutches, manual transmissions, automatic transmissions, transfer case and auxiliary gearbox, transaxle and front wheel drive, drive trains, wheels and tires
9 (39 hours)	Brakes, air brakes
10 (86 hours)	Introduction to diesel, unit fuel injection system, distributor fuel injection system, Cummins diesel engine fuel system

Operations Analysis. The transportation vehicle maintenance flight of the 178th Fighter Group employs seven full-time technicians in its efforts to maintain the unit's vehicle fleet. Personnel authorizations for vehicle maintenance activities are based upon the number of vehicle "equivalents" maintained. These technicians are supplemented by eighteen traditional (part-time) guardsmen two days per month and two weeks per year. Over the past year, this flight has achieved an in-commission rate of over ninety-three percent for the ninety-seven vehicles maintained.

All full-time technicians "crossflow" between special purpose and general purpose vehicles. No clear distinction is evident between general purpose and special purpose vehicle maintenance in this flight, and there is an obvious overlap between these

Table 4-5. Sequence of Vehicle Maintenance Upper Block Training
(Department of the Air Force, 1996a/b/c)

Block	Description
	Special Purpose Vehicle and Equipment Maintenance
I (70 hours)	Operation and maintenance of cargo loaders
II (65 hours)	Servicing vehicles
III (58.5 hours)	Sweepers, snow plows, snow brooms, snow blowers, scrapers
IV (40.5 hours)	Operation and maintenance of forklifts and towing vehicles
V (38 hours)	Cranes and crawler tractors
	Special Vehicle Maintenance, Refueling Vehicles
I (102 hours)	R-9 refueler O/I maintenance
II (82 hours)	R-11 refueler O/I maintenance
	General Purpose Vehicle Maintenance
I (56 hours)	Hazardous communication training, fundamentals of computer control systems, isolate computer system malfunctions, Quality Air Force awareness training

two work centers. Depending on the needs of the flight's customers, special purpose vehicle mechanics will often work on general purpose vehicles (and vice versa). According to the latest OSR, this overlap is common among transportation vehicle maintenance units. Due to their limited training time, part-time guardsmen concentrate on only one category of vehicle.

Maintenance documentation on vehicles is maintained in the On-Line Vehicle Information Management System (OLVIMS). Access to this system is limited, and entries are accomplished by from Maintenance Control and Analysis (MCA). Using OLVIMS, MCA maintains centralized control over prioritization of tasks, utilization of

manpower, and expenditure of resources. Through the use of work orders, the MCA informs shop supervisors of scheduled work and TCTOs.

Only ten of the ninety-seven vehicles owned by the 178th Fighter Group are maintained on mobility status. Of these, all but three are special purpose vehicles, critical to the deployed operation of the group. All of the shop's technicians, full-time and part-time, maintain mobility status. A "repair as needed" philosophy is used during contingency operations.

Vehicle Maintenance Process. The process of scheduling and accomplishing maintenance is standardized for general purpose and special purpose vehicles, and this process has been charted in Figure 4-10. The user must bring the vehicle to the shop, and the Customer Service Center (CSC) reviews the required repairs. The CSC inspects the vehicle for obvious discrepancies, and debriefs the vehicle operator to assist in determination of maintenance requirements. Along with inputs from Maintenance Control and Analysis (MCA), the CSC will determine if major repairs are needed. It can waiver any worked deemed unnecessary, expediting the repair of the vehicle and its return to the user.

If major repairs are required, MCA will open a work order on that vehicle. An analysis of the work will determine if it meets cost criteria and is authorized. Generally, the one-time repair limit for a vehicle is seventy-five percent of its initial cost at the time of purchase, or the amount derived by multiplying the replacement cost by two and dividing this figure by the expended age in years, whichever is less (Department of the

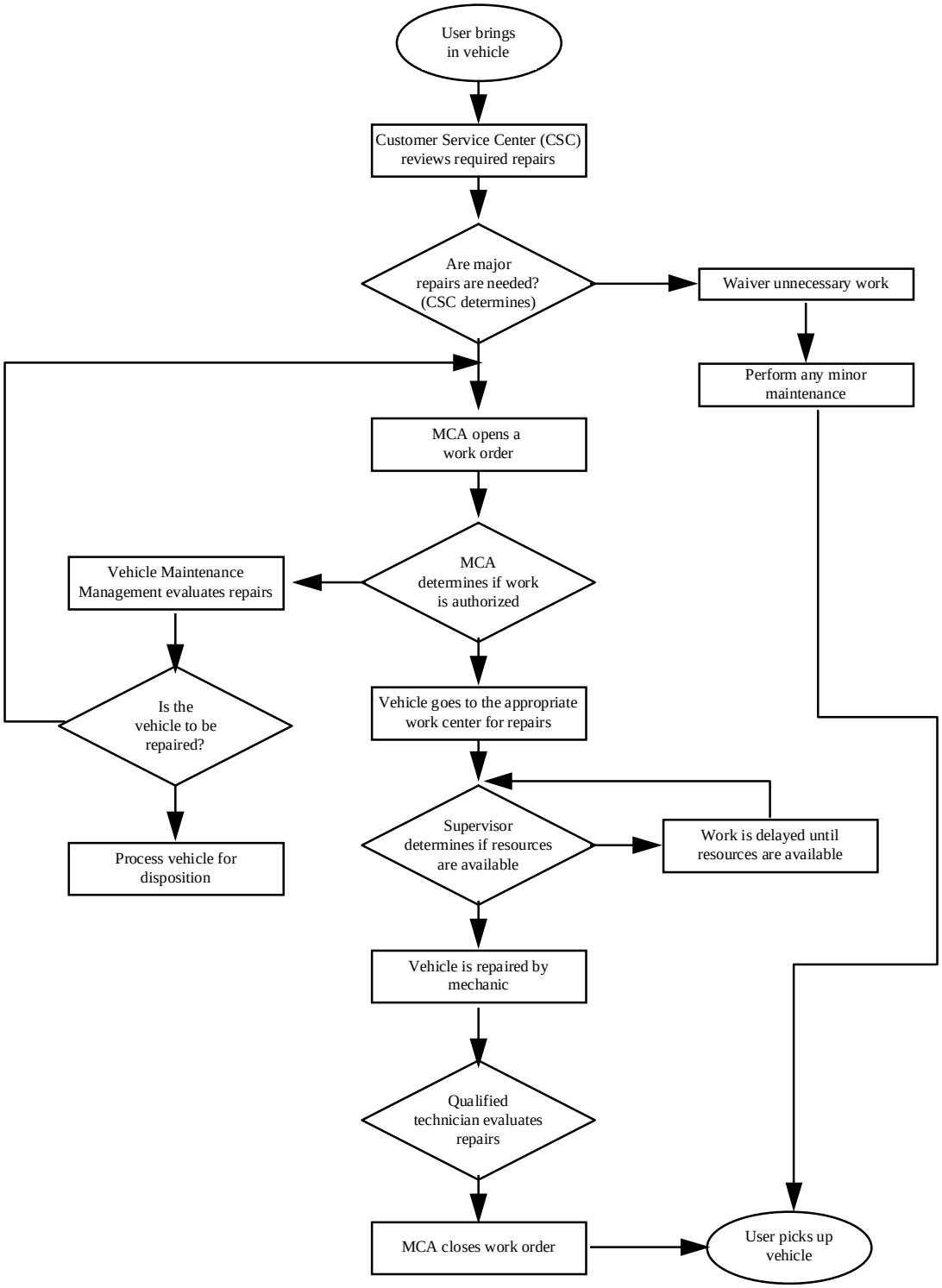

Figure 4-10. Vehicle Maintenance Process

Air Force, 1995f: 13). If the required repairs do not meet this criteria, Vehicle Maintenance Management (VMM) evaluates whether or not the repairs should be made. If VMM determines the repairs are not cost effective, the vehicle is processed for disposition. If the vehicle is mission-essential with no immediately available replacement, VMM can authorize minimum essential repairs.

Vehicles with authorized repairs are routed to the appropriate work center for maintenance. If resources are not available, work must be delayed on the vehicle. Once repairs are made and evaluated, the work order is closed by MCA, updating OLVIMS. The using organization is notified to pick up the vehicle.

Summary

This analysis of different work centers performing support equipment maintenance provides valuable information for developing organizational alternatives. This chapter presented findings of research on the tasks performed, skills required, and processes used in each area of support equipment maintenance. These findings are based upon an extensive review of appropriate Air Force directives, occupational survey reports, career field education and training plans, and technical training course documents. Additionally, support equipment maintenance activities of the 178th Fighter Group were observed and documented. This chapter established the current situation as a baseline for comparing these areas to determine the feasibility of consolidating or realigning support equipment maintenance. The next chapter presents alternatives for consolidation or realignment, focusing on the positive and negative aspects of each.

V. Alternatives

Chapter Overview

In chapter three, two options were identified as potential alternatives for the consolidation or realignment of support equipment maintenance. The first of these alternatives involved the realignment of MMHE and engine trailer maintenance under the AGE flight, aligning all aircraft-related support equipment maintenance in the Maintenance Squadron. Both MMHE and engine trailers are non-powered support equipment similar in operation and function to non-powered AGE. The realignment of each of these maintenance responsibilities under the AGE Flight will be addressed separately in this chapter, focusing on both advantages and disadvantages.

The second alternative entailed the wholesale consolidation of all logistics support equipment under the Transportation Squadron. The focus of this alternative is the practicality of consolidating AGE maintenance with special purpose vehicle and equipment maintenance. Both of these sections maintain powered support equipment that is alike in operation and function, but drawbacks to this consolidation exist. These two options are not the only available alternatives, but on the surface, they appear to be the most practicable.

MMHE

Currently, only non-powered MMHE is maintained by the Munitions Support Equipment Maintenance Section. Bomb lifts (MJ-1 and MHU-83) are maintained by the AGE flight, and AGE technicians receive extensive training in the maintenance and repair of this equipment. Other specialized powered MMHE is also maintained by AGE technicians where it is assigned. Munitions systems specialists only maintain non-powered munitions trailers and the chassis portion of universal ammunition loading system (UALS) units.

The reasons for the continued alignment of MMHE maintenance as a munitions systems function could not be ascertained in this research. However, the study of maintenance organizational evolution in chapter two of this thesis may lend some clues. Munitions operations have traditionally typified a centralized, vertically-integrated organization. Before the "Objective Wing," the Munitions Squadron stored weapons, built weapons, transported weapons, and loaded weapons onto aircraft. The squadron also maintained its own operations center, called "Munitions Control," that scheduled and directed all munitions-related activities. The nature of storing, building, controlling, and moving weapons creates an environment in which a centralized organization thrives. Along with these responsibilities, the maintenance of weapons release systems and MMHE was vertically aligned into this squadron. The integration of MMHE was natural in this environment, as it gave the Munitions Squadron control of almost all assets and resources needed to accomplish its mission.

The advent of the Objective Wing has significantly altered the centralization of munitions maintenance. The Armament Systems Flight and Munitions Systems Flight are now aligned under the Maintenance Squadron, and weapons load crews are assigned to operational flying squadrons. The role of Munitions Control has been greatly reduced, and in some units, it has been consolidated with other base control functions. The realignment of MMHE with other types of support equipment maintenance further flattens and decentralizes maintenance organizational structure.

Processes and Competencies. The comparison of the processes used, tasks performed, and competencies required in the maintenance of MMHE and AGE suggests a realignment of MMHE maintenance responsibilities to the AGE Flight. The processes observed in the maintenance of both MMHE and AGE are similar. The major difference is the lack of a need for servicing, pickup, and delivery of MMHE. This difference is not significant as it shows that the AGE flight would not increase its burden on the servicing, pick up, and delivery section. Both types of equipment are tracked in the Core Automated Maintenance System (CAMS), eliminating a need for the installation of a separate tracking system for MMHE.

The tasks performed in MMHE maintenance are more similar to those in the AGE Flight than to the tasks performed elsewhere in the munitions systems career field. Most munitions systems technicians work in jobs dealing either with munitions maintenance, missile maintenance, or storage, handling, and delivery of munitions. From the latest occupational survey report (OSR), a comparison of tasks performed by personnel in this specialty was accomplished. A comparison of the representative tasks performed by

MMHE maintenance technicians (Appendix D) and the rest of the career field shows no commonality in the tasks most commonly performed, even though these jobs are within the same specialty. However, most tasks performed by MMHE technicians are also performed by AGE technicians (Appendix B). Moving the responsibility of MMHE maintenance to the AGE Flight (and AGE technicians) would align like tasks under the same career field.

Training. The most significant impact of this realignment of maintenance tasks would be in training of technicians. Currently, munitions systems personnel receive no training in maintenance of MMHE. Technicians performing this maintenance must learn their job through on-the-job training (OJT), which can vary at each unit or base. Personnel maintaining AGE already receive training in many of the tasks accomplished in the maintenance of MMHE, and should be able to maintain MMHE without any significant increase in training.

Observations at the AGE shop of the 178th Fighter Group support this assertion. These AGE technicians already maintain two MHU-12 munitions trailers that have been converted by the unit to transport aircraft decontamination and de-icing equipment. Because maintenance tasks associated with these trailers are similar to those already accomplished, this additional responsibility has not caused an increased training burden. Similarly, the addition of other MMHE maintenance to the responsibilities of the AGE shop would only (at most) slightly increase AGE training requirements.

In the Munitions Flight, the elimination of the OJT needed for MMHE maintenance would save time and resources that could be applied elsewhere. It would

allow munitions systems technicians to utilize their training in their core competency, instead of performing tasks on which no formal training is provided.

Manpower/Costs. Although the reduction of manpower through this consolidation was a key reason for pursuing this research, no manpower savings would be realized under current Air Force manpower standards. Personnel authorizations in both the Munitions Flight and the AGE Flight are based upon the number of aircraft assigned to the unit, not pieces of equipment maintained or number of tasks performed. Immediate impact of this realignment would be a transfer of manpower authorizations along with the maintenance responsibility. Economies of scale achieved through consolidation would not be reflected in authorizations until a manpower study could be accomplished.

Air Force-wide, about six percent of all munitions systems technicians are currently employed in the maintenance of MMHE. Therefore, if the maintenance of MMHE was transferred to AGE, the Air Force could reduce the number of munitions systems personnel by six percent. This reduction of personnel translates to fewer students attending technical training. At a cost of $9,618 per student, and a trained personnel requirement (TPR) of 1225 in fiscal year 1996, a six percent reduction in students would have resulted in savings in excess of $700,000 for this one year alone (Miller, 1996).

In the operational analysis of the 178th Fighter Group, personnel in both the Munitions Flight and AGE Flight expressed the concern that they maintained an overabundance of support equipment. This opinion is supported by the low utilization of some equipment and the amount of equipment that the unit keeps in storage. A review of authorized equipment levels throughout the Air Force could reduce equipment

inventories, reducing both maintenance and personnel requirements and providing even further cost savings. This reduction in equipment inventories may even offset the additional equipment maintenance (and personnel) requirements brought about by the realignment of MMHE under the AGE Flight.

Consolidation of AGE maintenance and MMHE maintenance into the AGE Flight would also provide other cost savings that are more difficult to calculate. Inventories of high-use, low-cost replacement parts and hardware (bench stock items) could be reduced, because inventory locations would be reduced from two to one. Similarly, tool and shop equipment inventories would also be reduced.

Mission Impact. The effects of this realignment on mobility requirements are negligible. Most of the work involved in the maintenance of MMHE is preventive maintenance that can be accomplished prior to deployment. Sufficient numbers of AGE technicians maintain mobility status and can perform any necessary corrective maintenance while deployed. Munitions systems technicians, no longer burdened with MMHE maintenance, will be better able to focus on the increased need for building munitions.

Personnel. Positive effects of this change would be felt by personnel within the munitions systems career field. Previously, MMHE technicians tested for promotion along with others in the same career field. However, because the tasks and knowledge needed in their job were different from those in the rest of their career field, MMHE technicians were at a disadvantage when testing for promotion. With the movement of MMHE maintenance responsibilities to the AGE Flight, munitions systems personnel

will be better able to concentrate on their core competencies of maintaining, building, storing, and transporting munitions.

There are also a few minor drawbacks for munitions systems personnel in the realignment of MMHE maintenance under the AGE Flight. The current arrangement gives these technicians an opportunity to perform a wider variety of tasks, decreasing the monotony of their job. As a small work center within the Munitions Flight, the munitions support equipment shop also provides an additional supervisory positions for experienced technicians. Both of these opportunities would be eliminated by moving the responsibility for this equipment to the AGE Flight.

The biggest drawback to this reorganization would be the loss of control of the Munitions Flight over the maintenance of its equipment. The scheduling and prioritization of MMHE maintenance would now be controlled by the AGE Flight. An increased effort would be needed to coordinate and communicate maintenance requirements and schedules between the Munitions Flight and the AGE Flight. Because these flights are now located in the same squadron, this need for increased communication and coordination should not prove to be difficult.

Engine Trailers

Engine trailers are currently maintained in the Propulsion Flight by Aerospace Propulsion specialists. Like maintenance of MMHE by munitions systems technicians, this delegation of maintenance responsibilities is a remnant of centralized maintenance organizations. In the past, all propulsion system maintenance was controlled within the

propulsion shop. Technicians were dispatched to the flight line for on-equipment maintenance, and the same technicians performed engine tear down inspections in the back shop. Scheduling of engine maintenance and monitoring of engine status was accomplished in this shop, and all related tools and support equipment were maintained by engine technicians.

The decentralization of maintenance organizations and implementation of the "Objective Wing" has changed propulsion maintenance responsibilities. Flight line maintenance is accomplished by members of the flying squadrons, and back shop maintenance is assigned to the Maintenance Squadron. Engine scheduling and monitoring is now the responsibility of the Logistics Support Squadron. Although these changes have streamlined and flattened the organizational structure of the Propulsion Flight, further reductions are possible.

One of the principles of Lean Logistics is the implementation of two-level maintenance on the engine fleet. This change in maintenance concept eliminates jet engine intermediate repair (JEIM) at the base level. Engines that cannot be fixed on the flight line are removed from service and sent to the engine shop. Instead of repairing these discrepancies, the shop prepares for the engine for shipment to depot. The depot ships a serviceable replacement engine to the base, where it is checked on the test cell. The engine is maintained on the engine spare line until needed.

The application of two-level maintenance to jet engines has significantly altered the Propulsion Flight. Its primary activity has shifted from repairing jet engines to packing and shipping jet engines. Maintenance of engine trailers and the operation of the

engine test cell are the only remaining maintenance functions in the flight. Moving responsibility for engine trailer maintenance from the Propulsion Flight could further reduce the need for trained jet engine mechanics in the back shop and at the base level.

Processes and Competencies. The shifting of engine trailer maintenance responsibilities to the AGE Flight is a viable alternative. The processes observed in the maintenance of both engine trailers and AGE are similar. Like MMHE, engine trailers do not use a servicing, pickup, and delivery process. This difference is not significant as it shows that the AGE flight would not increase its burden on the servicing, pick up, and delivery section. The use of the Core Automated Maintenance System (CAMS) in the tracking of maintenance information is identical for both types of equipment.

Tasks performed in engine trailer maintenance (Appendix E) compare favorably to those performed by AGE technicians (Appendix B). Conversely, personnel maintaining engine trailers currently perform few tasks common to the rest of their career field. Moving the responsibility of engine trailer maintenance to the AGE Flight (and AGE technicians) would align like tasks under the same career field.

Training. As in the previous case, the most significant impact of this realignment of maintenance tasks would be in the training of technicians. Aerospace propulsion systems personnel receive no training in maintenance of engine trailers, and the technicians performing this maintenance must learn their job through on-the-job training (OJT), which can vary at each unit or base. This transfer of maintenance responsibility would eliminate an on-the-job training (OJT) burden on the Propulsion Flight. AGE technicians already receive training in many of the tasks accomplished in the maintenance

of engine trailers. The addition of engine trailers to their maintenance responsibilities may only slightly increase their training requirements.

Manpower/Costs. Due to current manpower standards (authorizations based upon assigned aircraft), there would be no immediate personnel savings. A manpower study should be conducted to investigate the effect of economies of scale, with manning levels adjusted accordingly. Until this study can be accomplished, the authorizations for engine trailer maintenance would most likely be transferred to the AGE Flight.

Currently, about three percent of all aerospace propulsion systems technicians are tasked to maintain of engine trailers. If the maintenance of this equipment were transferred to AGE, the Air Force could reduce the number of these personnel by three percent, reducing the number of students attending aerospace propulsion apprentice training courses. For a F-16 propulsion specialist, initial technical training costs $190 per student per day for a series of courses lasting 65 days (Manso, 1996). With a trained personnel requirement (TPR) of 538 in fiscal year 1996, a three percent reduction in students would have resulted in savings of almost $200,000 for this one year alone.

A reduction in equipment inventories would also reduce maintenance (and associated personnel) requirements. The operations analysis of the 178th Fighter Group suggested that authorized levels of assigned engine trailers may be too high. Unnecessary maintenance is performed due to low utilization of equipment and trailers in storage. An analysis of actual equipment needs could reduce inventories, lowering maintenance requirements. The savings realized through this reduction could offset the addition of engine trailer maintenance responsibilities (and personnel required) in the AGE Flight.

Mission Impact. The effects of this realignment of engine trailer maintenance on mobility and maintenance documentation is negligible. Preventive maintenance during contingencies would likely be deferred, and deployed AGE technicians would be available to handle corrective maintenance.

Personnel. Effects of this change on the aerospace propulsion career field would be similar to the effects discussed earlier on the munitions systems career field. Personnel currently performing engine trailer maintenance could be utilized in their core competency (jet engine maintenance), building their skills and knowledge of these systems and improving their chances for promotion. Drawbacks for the Propulsion Flight personnel caused by this realignment, such as loss of control over equipment maintenance and elimination of a work center (and associated supervisory position) are relatively minor when compared to potential advantages.

If the Air Force continues to pursue the adoption of two-level maintenance to all engines, another option exists for maintenance of engine support equipment. Because engine trailers are already shipped to depot when transporting engines, an engine trailer maintenance function could be established at the engine depots. These shops would not require active duty military personnel, and could be manned by civilian personnel or outsourced to a third party. Under this format, all preventive maintenance for Air Force engine support equipment could be provided in one or two locations. Economies of scale would be more significant, and AGE technicians could still provide base-level corrective maintenance support. If all engines in the Air Force inventory are projected to adopt a

two-level maintenance concept, this option of depot-level engine trailer maintenance warrants further investigation.

AGE

The last organizational alternative to be examined in this thesis is the realignment of all aerospace ground equipment maintenance under the Vehicle Maintenance Flight of the Transportation Squadron. Initially, this alternative appears feasible--both groups of specialists perform maintenance on powered mobile support equipment. Maintenance of powered AGE and special purpose equipment (forklifts, cargo handlers) seem to have the most in common. These two specialties will be compared here.

Processes and Competencies. A review of representative tasks performed by technicians in AGE maintenance (Appendix B) and special purpose vehicle and equipment maintenance (Appendix F) shows commonality among many tasks. However, tasks performed by AGE are broader, encompassing both organizational and intermediate level maintenance tasks on a variety of specialized equipment. Many AGE tasks are heavily influenced by the need to provide customer service in support of the mission. The AGE Flight provides servicing, pick up, delivery, and inspection of equipment on a daily basis. Transportation maintenance functions are much less supportive of the customer, providing only periodic preventive and corrective maintenance, and requiring customers to perform organizational level maintenance and servicing.
Comparison of maintenance processes in Figures 4-2, 4-3, and 4-10 shows further contrasts in organizational and maintenance philosophies. The lack of customer support in

vehicle maintenance for servicing, pick up, and delivery is most obvious. Once the maintenance process begins, further contrasts appear. Vehicle maintenance scheduling and prioritization is centrally-controlled, and cost is a major driver in determining the amount of repairs or level of service to be provided. AGE maintenance does not face such tight constraints, and is focused on meeting the needs of the flight line maintenance personnel it supports.

These two maintenance operations use different maintenance management systems. While AGE maintenance is tracked in the Core Automated Maintenance System (CAMS), special purpose vehicle and equipment maintenance is tracked in the OnLine Vehicle Maintenance Management System (OLVIMS). The features of these systems reflect the maintenance concepts used in these different maintenance centers. While both systems track equipment discrepancies and schedule maintenance, OLVIMS tracks costs, prints work orders, and tracks preventive maintenance requirements by both time and mileage. To allow depot access to AGE maintenance records, both systems would be necessary in a consolidated operation.

Training. Training issues will also seriously impact consolidation of AGE maintenance into the Vehicle Maintenance Flight. The present AGE course is a Mission Ready Technician (MRT) course, providing fully qualified personnel to the field. This initial skills training involves certification on many different pieces of equipment. Although there is overlap with the vehicle maintenance basic course in many conceptual areas, personnel in a consolidated work center would still need to complete 728.5 of the 848 hours from the current AGE course to establish a comparable level of proficiency.

This additional training, above and beyond the requirements of current vehicle maintenance apprentice training and upper block training, would add significant time and cost for new personnel. At the current cost of $239.10 per student per day for AGE training, this increased requirement will cost an additional $21,758 per student (McKellup, 1996). Total training time for special purpose vehicle and equipment maintenance technicians (including AGE tasks) would more than double, increasing to 1400 hours (175 days).

When training costs, training time, differences in information management systems, and differences in maintenance philosophies are all considered, sufficient reasons exist to dismiss this alternative. With five different specialties within the vehicle maintenance career field, many other opportunities exist for consolidation of maintenance responsibilities in the Vehicle Maintenance Flight. These opportunities need to be explored further.

Summary

In this chapter, support equipment maintenance consolidation and realignment options were presented and evaluated. These alternatives involved the realignment of MMHE and engine trailer maintenance under the AGE flight, and the consolidation of all aircraft support equipment under the Vehicle Maintenance Flight of the Transportation Squadron.

While the information gathered in this research supports the transfer of MMHE and engine trailer maintenance responsibility to the AGE Flight, the transfer of AGE

maintenance to the Transportation Squadron was unsupported. Consolidating MMHE and engine trailer maintenance under the AGE Flight shows potential to save unnecessary training expenditures without decreasing available support. It is recommended that this alternative support equipment maintenance organizational structure be implemented Air Force-wide.

VI. Conclusions and Recommendations

Chapter Overview

The final chapter of this thesis ties together the information presented in previous chapters. This chapter begins with a discussion of the issues surrounding this research and the relevance of these issues to the organization of support equipment maintenance in the Air Force. Most importantly, this chapter summarizes the research findings, answers the investigative questions, and provides conclusion and recommendations.

Research Issues

The scope of this research was quite broad. In an effort to compare and contrast support equipment maintenance functions, many factors were addressed. In chapter four, the tasks performed, skills required, and processes used in each area were outlined for comparison. A discriminating review of the maintenance tasks and processes used in different areas of support equipment maintenance was provided, and some alternatives were identified for future improvement through consolidation or realignment of capabilities and resources. Chapter five analyzed these alternatives and presented the advantages and disadvantages of each. By no means was this research intended to preclude the need for future study of support equipment maintenance organizational policy. To the contrary, this chapter presents areas of interest that should be the subject of intense scrutiny by senior logisticians.

Lean Logistics aims to reduce logistics costs while increasing efficiency through the use of simplified processes, improved management, increased flexibility, lower overhead, and reduced infrastructure. The latest Air Force base-level restructuring effort, the "Objective Wing," emphasized the streamlining and flattening of organizations to consolidate resources where practical. This realignment created a Maintenance Squadron under the Logistics Group, encompassing the maintenance of Aerospace Ground Equipment (AGE), Munitions Material Handling Equipment (MMHE), and engine trailers. However, these functions remain independent, even though they are located within the same squadron. Additionally, vehicles and special purpose equipment continue to be maintained in the Transportation Squadron, also under the authority of the Logistics Group Commander.

Findings

This research investigated the feasibility and consequences of consolidating or realigning maintenance of powered and non-powered AGE, MMHE, engine trailers, and special purpose vehicles and equipment into one consolidated maintenance shop or unit per base. This study consulted many sources, ranging from occupational survey reports and career field education and training plans to actual field observations of maintenance processes and unstructured interviews of maintenance personnel and supervisors.

Maintenance tasks, processes, and required competencies for support equipment maintenance activities within aircraft maintenance are similar. Aerospace ground

equipment technicians, due to the nature of their training, are better qualified to maintain MMHE and engine trailers than the munitions systems specialists or aerospace propulsion specialists. The realignment of maintenance responsibility for MMHE and engine trailers to the AGE Flight would reduce the training requirements for munitions systems specialist and aerospace propulsion specialists, realizing training cost savings of over $900,000 per year. Although control over MMHE and engine trailer maintenance scheduling by the owning work centers would be diminished, quality of maintenance provided should not.

Enough differences in training, maintenance information management systems, and maintenance philosophies exist between vehicle maintenance and AGE to dismiss the consolidation of these specialties. Additional costs incurred through added training requirements make this option impractical, but consolidation of specialties within the Vehicle Maintenance Flight may yield future benefits.

Areas for Further Research

Engine Trailer Two-Level Maintenance. If all engines in the Air Force inventory are projected to adopt a two-level maintenance concept, the option of depot-level engine trailer maintenance warrants further investigation. Engine trailers are already shipped to depot when transporting engines, and an engine trailer maintenance function could be established at the depots, manned by civilian personnel or outsourced to a third party. Similar to maintenance on jet engines, all preventive maintenance for Air

Force engine support equipment could be provided in one or two depot locations. Economies of scale would be more significant, and AGE technicians could still provide base-level corrective maintenance support.

Support Equipment Inventory Levels. Low utilization rates, high mission readiness rates, and large reserves of serviceable equipment in storage indicate excessive allocations of support equipment. The operations analysis of the 178th Fighter Group suggests excess inventories of AGE, MMHE, and engine trailers. Previous research by Beward and others (1996) indicated similar excesses in four AGE maintenance units analyzed. Excess inventories of equipment unnecessarily increase maintenance requirements, increasing costs and personnel utilization.

Vehicle Maintenance Organization. Five different specialties exist within the vehicle maintenance career field, and many opportunities exist for consolidation of maintenance responsibilities in the Vehicle Maintenance Flight. The latest Occupational Survey Report (OSR) for the vehicle maintenance career ladder states that a high degree of commonality exists between these specialties. Field observations of the 178th Fighter Group showed little distinction between general purpose maintenance specialists and special purpose vehicle and equipment maintenance specialists, and there is an obvious overlap between these two work centers. Depending on the customer needs, special purpose vehicle mechanics will often work on general purpose vehicles (and vice versa). Further research into consolidation of these specialties is justified.

Chapter Summary

The intent of this thesis was to present support equipment maintenance consolidation and realignment options. The feasibility and consequences of different organizational alternatives were evaluated. While the information gathered in this research supports the transfer of MMHE and engine trailer maintenance responsibility to the AGE Flight, the transfer of AGE maintenance to the Transportation Squadron was unsupported. It is recommended that the first alternative be implemented Air Force-wide.

It is my hope that this thesis has provided valuable information and insight into how support equipment maintenance is organized and accomplished in the Air Force. Like any policy change, this shifting of maintenance responsibilities cannot be expected to happen overnight. With careful planning and implementation, efficiencies can be realized in this often-overlooked facet of maintenance. There is no air power without ground power, and improving efficiencies in this area will prepare us to more effectively meet the challenges of the future.

Appendix A: Glossary of Acronyms

AETC	Air Education and Training Command
AF	Air Force
AFB	Air Force Base
AFJQS	Air Force Job Qualification Standard
AFOMS	Air Force Occupational Measurement Squadron
AFR	Air Force Regulation
AFSC	Air Force Specialty Code
AGE	Aerospace Ground Equipment
AGS	Aircraft Generation Squadron
AMS	Avionics Maintenance Squadron
AMU	Aircraft Maintenance Unit
CAMS	Consolidated Aircraft Maintenance System
CAS	Combat Ammunition System
CBO	Congressional Budget Office
CC	Course Chart
CFETP	Career Field Education and Training Plan
COMO	Combat Oriented Maintenance Organization
CRS	Component Repair Squadron
CSC	Customer Service Center
DCM	Deputy Commander for Maintenance
DCR	Deputy Commander for Resources
DoD	Department of Defense
ECM	Electronic Countermeasures
EMS	Equipment Maintenance Squadron

FMS	Field Maintenance Squadron
FOB	Foward Operating Base
FTD	Field Training Detachment
ITRO	Interservice Training Review Organization
JEIM	Jet Engine Intermediate Maintenance
MAC	Military Airlift Command
MAJCOM	Major Command
MCA	Maintenance Control and Analysis
MMHE	Munitions Material Handling Equipment
MMS	Munitions Maintenance Squadron
MOB	Main Operating Base
MRT	Mission Ready Technician
NOCM	Nuclear Ordnance Commodity Management
NSS	Noise Suppression Systems
OJT	On-The-Job Training
OLVIMS	On-Line Vehicle Information Management System
OMS	Organizational Maintenance Squadron
OSR	Occupational Survey Report
PACAF	Pacific Air Forces
POMO	Production Oriented Maintenance Organization
REMCO	Rear Echelon Maintenance Combined Operations
ROLS	Readiness Oriented Logistics System
SAC	Strategic Air Command
STS	Specialty Training Standard

TAC	Tactical Air Command
TACS	Tactical Air Control Squadron
TCTO	Time Compliance Technical Order
TPR	Trained Personnel Requirement
U&TW	Utilization and Training Workshop
UALS	Universal Ammunition Loading System
VMM	Vehicle Maintenance Management

Appendix B. Representative AGE Tasks

TASK	Percent Members Performing
Clean AGE	78
Clean and gap spark plugs	71
Remove or install electrical fuses	71
Perform air compressor pre-operations inspections	70
Perform air compressor service inspections	69
Remove or install batteries	69
Remove or install spark plugs	68
Paint, stencil, or mark AGE	68
Adjust brake systems	67
Solder electrical system wiring	66
Fuel AGE	66
Perform light cart pre-operations inspections	66
Clean or paint battery boxes	66
Initiate or annotate AFTO Forms 350	66
Perform heater pre-operations inspections	66
Remove or install AGE tire, tube or wheel	65
assemblies	65
Perform heater service inspections	65
Perform generator service inspections	64
Perform light cart service inspections	64
Perform generator pre-operations inspections	64
Remove or install battery cables	63
Pick up or deliver AGE	63
Operate two-way vehicle radios	63
Perform brake system operational checks	62
Splice electrical system wiring	62
Pack wheel bearings	62
Reflectorize AGE	62
Clean or wax vehicles	62
Clean contactor points	61
Annotate or complete AFTO Forms 244 or 245	61
Remove or install manual toggle switches	61
Perform load bank pre-operations inspections	

(Department of the Air Force, 1992a: 25)

Appendix C: 178th Fighter Group AGE Equipment

Powered AGE			
Category	**Type**	**Assigned**	**Mobility**
Air Cart	A/M 32A-60	9	9
	A/M 32A-95	1	0
Air Compressor	MC-2A	10	7
	MC-7	5	4
	MC-11	4	4
	MC-1A	2	2
Air Conditioner	A/M 32A-10C	10	9
	A/M 32A-5	2	0
Blower	A-1	2	0
Bomb Lift	MJ-1B	12	9
	MHU-83	8	7
Cabin Leakage Tester	AF/M 32T-1	2	1
De-icing Unit	SA-700	1	1
Decon Trailer	MHU-12/M	1	1
Defuel Trailer	SA-1A	1	0
Frequency Converter	EPU-6	7	0
Generator	A/M 32A-86	2	0
	MB-8	2	0
	MD-4	1	0
	MAP 806A	1	0
	4MB-1	1	0
	MAP-16	2	2
Heater	H-1	15	6
	HDU-13M	1	0
Hydraulic Power Cart	MJ-2A-1	2	2
	TTU-228E-1B	2	1
	A/M 27T-2A	1	0
Light Cart	NF-2	10	10
	TF-1	6	5
Load Bank	MA-24T8	1	1
Purge Unit	GSU-62M	1	0
Start Cart		1	1
Tow Vehicle		2	2
Vacuum Pump	KS-13A	1	0
Welder	44D	1	0

Non-Powered AGE			
Category	**Type**	**Assigned**	**Mobility**
Aircraft Towbar		5	4
Aircrew Ladder		16	12
Dolly	Centerline	4	3
Dolly	Scissors	2	2
Engine Screen		3	3
Fuel Bowser	200 Gallon	4	0
Jack	10 Ton Tripod	9	9
Jack	15 Ton Axle	3	2
Landing Gear Skate		2	2
Maintenance Stand	B-4	5	4
Maintenance Stand	C-1	5	2
Maintenance Stand	B-1	4	3
Portable Crane		1	1
Servicing Cart	Engine Oil	3	2
Servicing Cart	Hydraulic Oil	3	3
Servicing Cart	Liquid Oxygen	2	1
Servicing Cart	Gaseous Nitrogen	1	3
Servicing Cart	Liquid Nitrogen	1	2
Trailer (Jack)		1	1

Appendix D: Representative MMHE Tasks

TASK	Percent Members Performing
Remove or install tires, wheels, or tube on munitions trailers	98
Remove or install wheel bearings on munitions trailers	96
Adjust brakes on munitions trailers	96
Lubricate munitions support equipment	95
Remove or install brake components on munitions trailers	93
Remove or install lights on munitions trailers	90
Clean munitions support equipment	89
Locate and repair malfunctions within hydraulic systems on munitions trailers	89
Perform PIs of munitions support equipment	88
Perform service inspections of munitions support equipment	88
Drain or refill hydraulic systems on munitions trailers	88
Perform pre-use or post-use inspections of munitions support equipment	87
Visually inspect accessory parts for munitions support equipment	87
Perform corrosion control on munitions support equipment	86
Remove or install hydraulic system components on munitions trailers	82
Remove or install air and fluid tubes or hoses on munitions trailers	79
Locate and repair malfunctions within electrical systems on munitions support equipment	77
Rebuild hydraulic system cylinder or valve assemblies on munitions trailers	75
Maintain accessory parts for munitions support equipment	66
Complete AFTO Forms 350	65
Annotate AFTO Forms 244	62
Mask munitions support equipment for spray painting	59
Install solderless connections on munitions support equipment	55
Perform TCTO modifications of munitions support equipment	51

(Department of the Air Force, 1990: A7)

Appendix E: Representative Engine Support Equipment Tasks

TASK	Percent Members Performing
Adjust engine trailer brakes	96
Clean and pack engine trailer wheel bearings	96
Inspect and service engine trailer tires	95
Clean engine trailers or stands	94
Paint and mark non-powered engine support equipment	92
Assemble or disassemble engine trailer parking brake assemblies	91
Assemble or disassemble engine trailer wheel and hub assemblies	91
Inspect and service engine trailer hydraulic systems	89
Maintain inspections status of non-powered support equipment	87
Perform periodic inspections of general support equipment	87
Remove or install engine trailer parking brake assemble components	84
Perform operational checks of engine installation/ removal trailers	84
Remove or install lift cylinders on engine installations/ removal trailers	81
Complete AFTO Forms 350	77
Inspect non-powered support equipment, other than engine-related	77
Perform front-end alignment of engine trailers	76
Inspect engine trailers or stands	73
Lubricate engine hoist assemblies	70
Complete AF Forms 2005 (issue/turn-in request)	68
Complete AFTO Forms 349	65
Complete AFTO Forms 244 and 245 (industrial/ support equipment record)	62

(Department of the Air Force, 1989: A12)

Appendix F: Representative Vehicle Maintenance Tasks

Special Purpose Vehicles and Equipment

TASK	Percent Members Performing
Inspect or adjust engine drive belts	87
Remove or install batteries	84
Charge batteries	84
Service batteries	79
Service air cleaners	78
Remove or install spark plugs	78
Inspect charging systems	76
Adjust parking brakes	76
Pack wheel bearings	70
Remove or install seals	69
Adjust service brakes	69
Remove or install vehicle light assemblies	68
Bleed or flush brake systems	65
Steam clean engines and chassis	62
Manufacture gaskets	55
Isolate lighting system malfunctions	55
Inspect seals, other than engine, transmission, driveline, or steering	55 52
Inspect cooling systems	48
Service battery carrier assemblies	

(Department of the Air Force, 1992b: 40)

Special Purpose (Crash/Fire) Vehicles

TASK	Percent Members Performing
Inspect batteries	88
Inspect or adjust engine drive belts	88
Remove or install spark plugs	86
Charge batteries	85
Remove or install batteries	85
Adjust fire-fighting pump packings	83
Road test vehicle	77
Isolate crash fire-fighting pumping system	75
malfunctions	74
Adjust turret cables	74
Inspect fire-fighting equipment water or foam tanks	74
Isolate fire-fighting pumping system malfunctions	73
Adjust fire-fighting equipment turret electrical system components	73
Isolate fire-fighting equipment turret electrical system malfunctions	72
Isolate fire-fighting equipment turret hydraulic system malfunctions	72
Adjust fire-fighting pumping system relief valves	69
Repack fire-fighting pumps	66
Adjust fire-fighting equipment pump clutches	64
Analyze causes of vehicle failures	58
Conduct vehicle quality control inspections	45

(Department of the Air Force, 1992b: 41)

Special Purpose (Refueler) Vehicles

TASK	Percent Members Performing
Inspect or adjust engine drive belts	91
Inspect batteries	88
Remove or install refueling hoses	85
Remove or install batteries	85
Inspect refueling servicing nozzles	84
Test antifreeze solutions	83
Remove or install refueling equipment filters	82
Inspect lighting systems	79
Service batteries	78
Service air cleaners	77
Remove or install refueling equipment vitaulic couplings	77
Remove or install seals	74
Inspect tools	71
Service cooling systems	68
Analyze causes of vehicle failures	60
Test Mack/Kovatch R-9 systems	60
Isolate R-5 or Dodge R-9 system malfunctions	60
Inspect tires for serviceability	59
Calibrate gauges	56
Remove or install magnetos	54

(Department of the Air Force, 1992b: 42)

General Purpose Vehicles

TASK	Percent Members Performing
Inspect or adjust engine drive belts	86
Inspect batteries	82
Remove or install batteries	82
Charge batteries	78
Inspect charging systems	77
Road test vehicles	76
Service air cleaners	76
Service batteries	76
Remove or install engine drove belts	76
Inspect starting systems	74
Remove or install spark plugs	74
Remove or install seals	58
Lubricate vehicles	58
Inspect seat belts	65
Remove or install brake shoes	65
Remove or install drums and rotors	65
Inspect driveshaft components	62
Steam clean engines and chassis	59
Analyze causes of vehicle failures	51
Inspect tools	49

(Department of the Air Force, 1992b: 43)

Vehicle Body Maintenance

TASK	Percent Members Performing
Adjust hinges or locking mechanisms	92
Prepare vehicle body surfaces for painting	89
Perform corrosion control procedures	89
Apply chemical fillers, such as rubber, plastic, and bondo	88
Remove and install locks or latches	88
Remove or install hinges	88
Apply lettering or identifying insignias to vehicle bodies	87
Cut plexiglass	86
Remove or install bumpers	85
Cut safety glass	85
Repair corrosion damaged areas	83
Fabricate or mend upholstery	81
Weld exhaust system components	77
Apply fiberglass fillers	76
Apply polyurethane points	76
Construct seat covers	69
Apply acrylic paints	68
Apply lacquer-based primer fillers	66
Spot paint body panels using acrylic enamel	66
Apply primer sealers	59

(Department of the Air Force, 1992b: 44)

Appendix G: 178th Fighter Group Vehicles

Type	On-hand
Ambulance	1
Bobtail	7
Bus (28 pax)	1
Dump Truck	3
Fire Truck	6
Forklift	5
Pickup (4X4)	3
Refueler	4
Sedan	2
Snow Blower	1
Snow Plow	2
Snow Sweeper	1
Station Wagon	1
Sweeper	2
Telephone Truck	1
Tow Tractor	7
Tractor (John Deere)	2
Truck (4Dr)	4
Truck (compact)	13
Truck (Metro)	13
Truck (pickup)	4
Truck Tractor	2
Truck Trailer (Flatbed)	2
Truck Trailer (Low Boy)	1
Truck Trailer (Van)	1
Vacuum Sweeper	1
Van	4
Warehouse Tug	3
TOTAL	97

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Vita

Captain James C. Katrenak is from Lisle, Illinois. He graduated from the University of Illinois 1986 with Bachelor of Science degree in Aeronautical and Astronautical Engineering, and received his commission into the United States Air Force through Officer Training School in 1988. After completing the Aircraft Maintenance Officer Course (AMOC), Captain Katrenak was assigned to the 5th Bombardment Wing (BMW) at Minot AFB, North Dakota.

During his tour at Minot AFB, Captain Katrenak filled a variety of maintenance positions in support of both B-52H and KC-135A aircraft. These positions included assistant maintenance supervisor of the 5th Field Maintenance Squadron, Officer in Charge (OIC) of the Aircraft Readiness Center (ARC), OIC of the Tanker Branch, and OIC of the Bomber Branch.

In 1992, he was assigned to Sheppard AFB, Texas, where he served three years as an instructor for the Aircraft Maintenance Officers Course (AMOC). While at Sheppard, he earned the rating of Air Education and Training Command (AETC) Master Instructor, and completed a Master of Science degree in Corporate Training and Development from the University of North Texas.

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13. ABSTRACT (*Maximum 200 Words)*

The adoption of the "Objective Wing" organization in the United States Air Force has realigned many base-level maintenance functions. Support equipment is currently maintained and accounted for by several units under the Logistics Group Commander. This research determined the feasibility and consequences of consolidating or realigning maintenance of powered and non-powered AGE, MMHE, engine trailers, and vehicles into one consolidated maintenance shop or unit per base. This study consulted many sources, ranging from occupational survey reports and career field education and training plans to actual field observations of maintenance processes and unstructured interviews of personnel and supervisors. This study determined that maintenance tasks, processes, and required competencies for support equipment maintenance activities within aircraft maintenance are similar. Enough differences in training, maintenance information management systems, and maintenance philosophies exist between vehicle maintenance and AGE to dismiss the consolidation of these areas.

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