RESEARCH STUDIES SERIES

MILITARY AIRLIFT AND AIRCRAFT PROCUREMENT:

THE CASE OF THE C–5A

By

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PREFACE

This is the third in a series of research studies—historical works that were not published for various reasons. Yet, the material contained therein was deemed to be of enduring value to Air Force members and scholars. These were minimally edited and printed in a limited edition to reach a small audience that may find them useful. We invite readers to provide feedback to the Air Force History and Museums Program.

The author, Marcelle S. Knaack, a member of the Office of Air Force History, undertook the research and writing of this book as a consultant, after she retired. Tragically, she passed away in November 1996, before she completed the manuscript. Her colleague, Bernard C. Nalty, also retired by that time, undertook to complete Ms. Knaack's work.

At first glance, the history of the C–5A Galaxy seems to be nothing more than a compilation of contradictions. Ordered under a totally new procurement concept specifically designed to control costs, the C–5A aircraft ended up costing a small fortune. Its purchase in 1965 depended on achieving an initial operational capability no later than 1969, but the transport did not appear in South Vietnam in a truly operational capacity until August 1971. Although built by the Lockheed-Georgia Company, celebrated for its success with military transports like the C–130 Hercules and C–141 Starlifter, the C–5A program from the very start encountered serious technical problems, delays, and exorbitant cost overruns, which combined to trigger several congressional investigations.

Although the program contracted in size under the pressure of these failings, it survived congressional opposition and began to demonstrate its unique value during the last year of the Vietnam War, even though operating under weight restrictions. In October 1973, moreover, the C–5A helped provide Israel with a constant flow of supplies to ensure victory over the attacking Egyptian and Syrian armies.

Into the 1980s the C–5A operated under increasingly stringent flying restrictions because the flawed wing structure deteriorated until it had to be replaced. While under these restrictions, the C–5A could carry just 174,000 pounds of cargo, roughly 100,000 pounds more than the C–141, but 46,000 pounds less than the Galaxy's design objective. Although installation of the heavier new wing would probably prevent the airplane from ever attaining the design capacity of 220,000 pounds, the Military Airlift Command was determined to extend the service life of the C–5A because its performance remained so impressive even with a reduced load.

The improvements that strengthened the structure of the C–5A were incorporated in a new version of the Galaxy, the C–5B, for which Lockheed-Georgia reopened its production line. The modified A-model and the new C–5B did everything expected of a heavy-logistics transport during the Persian Gulf War of 1990-1991.

Jacob Neufeld, General Editor
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This book was suggested by Gen. Duane H. Cassidy, Commander in Chief of the Military Airlift Command from 1985 to 1987, and by the late Lt. Gen. Ralph E. Havens, Commander of the Air University, when both were members of the Air Force Historical Advisory Committee during the years 1988 and 1989. Generals Cassidy and Havens believed that the Air Force needed an impartial account of the C–5A program. Dr. Richard H. Kohn, the Chief of Air Force History, launched the book, which came to fruition under his successor, Dr. Richard P. Hallion.

In pursuing the objectives of accuracy and candor, I received advice and other assistance from several of my colleagues in the Air Force history program: Herman Wolk, Bernard C. Nalty, Jacob Neufeld, Wayne W. Thompson, Michael H. Gorn, R. Frank Futrell, and Michael Levy. Another Air Force historian, R. Cargill Hall, not only arranged the contract for completing the book but also offered comments and information that helped ensure the kind of product that Generals Cassidy and Havens wanted. Historians Richard K. Smith and Rene J. Francillon, also shared their extensive knowledge of the C–5A in particular and aerodynamics in general.

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INTRODUCTION

Acquisition of the C–5A and C–5B transports manufactured by the Lockheed-Georgia Company between 1969 and 1989 embodied both the struggle to control the cost of weapon systems and the emergence of military airlift as a key element of national strategy. Even though the improved C–5B incorporated changes in engines and airframe typical of a second production model of the basic C–5A, the two versions symbolized different eras and the development of new procurement concepts. Both, however, reflected the growing importance of long-range air transport.

The C–5A experienced a multitude of technical problems. Critical weakness in the wing, production slippage, and cost overruns nearly caused the program's cancellation in 1970. Yet, the new aircraft made a reality of the concept of flexible response by providing truly global reach for Air Force and the Army. The C–5A also signaled the beginning of drastic procurement reforms that sought to curb the cost of new weapon systems, though unsuccessfully since the new and highly publicized concept of total-package procurement was never pushed to its logical conclusion.

By the end of the 1980s, the C–5A and C–5B had become synonymous with American military airlift. The C–5A in particular—along with two previous Lockheed products, the C–130 and C–141—may well have raised the airlift forces to the status of a specified command, operated by the Air Force on behalf of the Joint Chiefs of Staff. This change of status for the Military Airlift Command occurred on February 1, 1977, when the combined tactical and strategic airlift forces in effect became a combat command. The organizational change ratified the nation's greater reliance on aerial mobility to fight limited wars in an era of nuclear parity between the United States and the Soviet Union. Acquisition of the C–5B in December 1982 confirmed anew that airlift had become the key to national military strategy.

The Vietnam War—Americanized in 1965, Vietnamized beginning in 1969, and liquidated in January 1973—demonstrated the need for a long-range cargo aircraft like the C–5A, but the expense of fighting that war caused the media and the public to question defense expenditures, especially for the new transport with its endlessly spiraling costs. To control the very costs that now seemed excessive, Robert Charles, the Assistant Secretary of the Air Force for Installations and Logistics, had devised total-package procurement.

Charles, a veteran of the aerospace industry, had come to believe that contractors routinely and deliberately underestimated the cost of development to win a contract for that purpose and thus maneuver themselves into position to become the sole source for a more lucrative production contract. Total-package procurement, Charles suggested, would inhibit this sort of buying-in, encourage the industry to design for economic production, motivate the contractors to control cost, and obtain long-term commitments leading to program stability and continuity. According to Charles, his new procurement method offered the government an opportunity to shift to the contractors the major financial risks, as well as responsibility for day-to-day management. After reflecting on his reforms, however, Charles apparently decided they were so harsh they might destroy the contractor, Lockheed-Georgia, and the airplane it was building. He, therefore, set about creating loopholes that protected the company, though at the cost of discrediting total-package procurement, which has yet to be used a second time.

The collapse of total-package procurement revived the authority of the system project offices, through which the Air Force Systems Command exerted its authority. A new tide of procurement reform, championed by Melvin Laird, President Richard M. Nixon's Secretary

of Defense, and David Packard, Laird's principal deputy, engulfed the C–5A and other programs beginning in 1969. Packard began to decentralize the entire acquisition process, trusting the system project offices to pool the efforts of development, logistics, and procurement agencies. Packard emphasized the importance of prototypes, giving rise to the slogan "Fly Before Buy." Competition among prototypes had taken place in the 1930s and proved expensive; it did not reduce costs in the 1970s. Even in the 1980s, an era of lavish military expenditures, the Department of Defense sought to strengthen management and reduce cost, though without again centralizing control. For all practical purposes, the quest to improve military procurement remained a continuing process, begun decades before the C–5A and lasting beyond the appearance of the C–5B.

The spectacular airlift during the latter stages of Vietnam War by a few carefully selected C–5As demonstrated the importance of the aircraft in a strategy of flexible response. Almost twenty years later, the C–5B joined the heavily modified C–5A in supporting the deployment of forces for the Gulf War. This demonstration of "Global Reach" during the buildup in the Persian Gulf region confirmed that airlift had become essential to both the Air Force and the nation. The C–5 Galaxy vindicated the airlift forces, dismissed for years as mere "trash haulers."

CHAPTER I

MILITARY AIRLIFT AND THE EVOLUTION OF AIRCRAFT PROCUREMENT.

The Lockheed C–5A transport, often cited as an example of development and procurement costs soaring out of control, was a product of the latest battle in a campaign to control weapon costs and ensure quality that antedated the invention of the airplane and more often than not ended in failure. The total-package procurement concept, which produced the C–5A military transport, failed in its only application, in the process causing bitter controversy. Despite criticism, shifting viewpoints, and sometimes disappointing performance, the aircraft, nicknamed the Galaxy in March 1968, became both the national symbol and the means of aerial mobility, helping to inspire the Air Force slogan of the 1990s—Global Power, Global Reach.[1]

Early Procurement Practice

Cronyism in the purchase of weapons presented problems even before the Civil War, and that conflict made them worse. Scarcely had the fighting begun, when Congress in 1861 passed new legislation that sought to ensure competition for military contracts, and consequently lower costs, by openly soliciting bids. A subsequent congressional statute specified in 1884 that the contract would go to the lowest responsible bidder with the best and most suitable article. The statute allowed some exceptions, however, among them the so-called "sole source" form of procurement for the purchase of spare parts, which could be purchased more cheaply from the present manufacturer, and for the acquisition of items either protected by patent or produced by only one manufacturer.[2]

In 1901, a new statute incorporated all the previous rules into a single law designed to ensure that in every case the government's interest in economy and competition would prevail. Because of circumstances, this legislation came to apply to the new field of aircraft procurement. In 1898, before the codification, Samuel Pierpont Langley, with the help of his influential friend Charles Doolittle Walcott of the U.S. Geological Survey, obtained $50,000 from the War Department to develop a full-scale, heavier-than-air, man-carrying flying machine. This project, which ended in December 1903 with the second crash and destruction of the experimental plane, aroused in the nation's newspapers a combination of mirth at Langley's rashness in challenging the skies, and outrage at the spending of public money on so foolish an enterprise.

The wave of criticism helped shape the procurement policy of President Theodore Roosevelt's War Department, which cited the new law while insisting that no contract would be let without competition. As a result, in 1908, when competition in the field of aviation remained limited to a few genuine pioneers and a larger number of charlatans, the Signal Corps had to allow all interested parties to compete for a contract to build an airplane for its use. Procurement officers issued specifications and requested bids for a heavier-than-air flying machine capable of carrying two men weighing an aggregate of 350 pounds, with sufficient fuel to fly for 125 miles. Although twenty-two bids were received, only that submitted by Orville and Wilbur Wright proved at all realistic. The Wrights, who had been flying their biplanes since December 1903, agreed to build one to meet War Department specifications and also to train two pilots—all for a basic fee of $25,000.[3]

In peacetime, most of the weapon contracts let through competition were of the fixed-price type, also known as lump-sum contracts, which established in advance the price the

government would pay, The contractor could increase his profits by lowering his costs through improved efficiency, provided his product performed satisfactorily; if he failed, however, his losses could be enormous. Most contractors were reluctant to assume the risks involved.[4]

Not so the Wrights, who had been building and flying powered airplanes for almost five years. The War Department contract (No. 486) they signed in 1908 minimized the government's potential loss, while inducing the brothers to take chances. The contract called for the payment of $25,000 for a "flying machine" that would achieve a velocity of 40 miles an hour, but it also carried both incentive and penalty provisions which linked performance with price. The Wrights would receive an extra $5,000 if the plane achieved 42 miles an hour but would be penalized $5,000, reducing their total payment to $20,000, if it reached only 38 miles an hour. The Wrights signed the contract, earned the incentive, and collected $30,000.[5]

During World War I, the federal government drastically altered its procurement procedures to encourage the aircraft industry's expansion and participation in military aviation. In effect, Congress authorized War Department officials to negotiate contracts as they saw fit. The Supply Division of the Office of Chief of the Air Corps handled wartime Air Corps procurement from Washington, D. C. In 1926, however, the division moved to Wright Field, Ohio, and became the Procurement Branch of the Air Corps Materiel Division, which had moved from its original location at nearby McCook Field.

Despite the wartime expansion of negotiating authority, conventional fixed-price contracts remained legal, though they proved totally unattractive to manufacturers facing rising costs for material and labor. As a result, the fixed-price approach gave way to the cost-plus-percentage-oF–cost (CPPC) contract, a form of procurement that shifted most development and financial risks to the government, which paid the contractor for all materials and labor. Since the contractor also received an agreed-upon percentage of the accrued costs, the CPPC contracts made it difficult to induce contractors to minimize costs. The problem was compounded when it came to the mass production of airplanes, a process full of uncertainties. In an attempt to keep prices down, members of the Aircraft Board devised a modified version of the cost-plus contract, later known as the bogey contract. This agency, previously the Aircraft Production Board, was enlarged and redesignated in October 1917. The Aircraft Board established aircraft requirements and placed contracts for the production of aircraft and related material.[6]

Under the terms of the modified CPPC or bogey contract, the government paid the contractor for all labor, material, depreciation, and overhead charges, as well as for special tools and all additional facilities required, though it retained title in to the tools and facilities. The contractor had to estimate his costs in advance, and his fee represented a fixed percentage of the estimated costs. The contractor, therefore, could not increase his profit if actual costs exceeded the estimated amount agreed upon. To induce the contractor to reduce costs, the modified CPPC also promised the contractor a special bonus that amounted to a substantial percentage of any money saved by reducing costs below the initial estimate.[7]

The modified cost-plus-percentage-oF–cost or bogey contract, when applied to airplanes and engines, did not work. Government officials set the bogey percentage in advance and had no factual data to compute eventual costs; consequently the price actually set tended to be very generous. With a 15-percent fee, for example, the manufacturer was ensured of a significant profit. If it became evident that actual costs would run far less than originally estimated, the bogey was renegotiated downward or the basic fee might be reduced. The contractor, however, was nevertheless assured of receiving a high percentage of the spread between the renegotiated figure and the actual costs. Moreover, on many occasions a large advance from the government supplemented the corporation's meager investment. Discovery

and public disclosure of excessive profits by aircraft manufacturers prompted a committee investigating wartime expenditures to recommend abolition of the cost-plus contract. The committee also urged Congress to revoke the Secretary of War's power to suspend competitive bidding, even during future emergencies.[8]

Post-World War I Promotion of Aircraft Development

During the first decade following World War I, public and congressional distrust of the weapons manufacturers hampered War Department procurement officers. Except in the case of experimental airplanes, when procurement officers negotiated with the manufacturer in an attempt to reach a mutually satisfactory price, almost all contracts, especially those calling for airplanes in production quantities, were let through competition that favored low-cost bidders. This process also did not work, in some instances actually penalizing the firms doing the most to advance the state of the aeronautical art. By 1925 the leadership in aviation bestowed on the United States by the pioneering Wrights had long ago vanished; the American military aircraft industry tottered on the verge of extinction while the unique technical advances took place abroad.[9]

These contracting problems led to procurement reforms championed by Rep. John Jackson McSwain, a Democrat from South Carolina who was an active member of the House Military Affairs Committee, and incorporated by Congress in Section 10 of the Air Corps Act of 1926. Although McSwain and his colleagues had the best of intentions when they stressed competition, the results once again proved disappointing. For example, the use of design competitions to purchase experimental aircraft, the only true procurement novelty in the Air Corps Act, sought to stimulate the country's inventive ingenuity and ensure the development of the American aircraft industry as a national resource in time of war, which, after all, was the new legislation's main purpose.[10]

In practice, design competitions for the procurement of experimental aircraft, whether used solely for research or found worthy of being produced in quantity, proved ineffective. Public invitations to compete generated a multitude of sealed bids, each containing graduated tables of prices on varying quantities of an aircraft proposed aircraft offered to meet rather general specifications. A selection board, acting for the Secretary of War, rated in percentiles every feature of the aircraft designs submitted by the eager but often inexperienced designers. Moreover, cost estimates rarely proved realistic, since the bidders offered only paper promises, and no detailed data existed upon which to base price figures for one or more aircraft. As a consequence, manufacturers tended to underestimate engineering complexity and therefore lose money on the airplanes that won these design competitions.[11]

Because design competition proved impractical, procurement officers decided to purchase experimental airplanes at negotiated prices, a procedure that they believed observed the letter, if not the spirit, of the 1926 law. Some successful experimental airplanes were bought at negotiated prices, but as a rule the manufacturers continued to lose money. They priced their experimental planes too low, underbidding each other in hopes of securing production orders that would enable them to recoup the initial losses. This was a gamble, however, since quantity production required a new competition—formal advertising, followed by an evaluation of the responses—a repetition of a process that favored the lowest bidder rather than the most qualified. In theory, the Secretaries of War and Navy could use their discretion to minimize price as a factor in awarding production contracts; in practice, to avoid political criticism, production contracts normally went to the lowest bidder.[12]

If the U.S. aeronautical industry was to survive, something more had to be done to

protect the interests of the manufacturers. Yet, War Department officials refused to propose amending or replacing the Air Corps Act, for fear that any new law might turn out to be more restrictive than the existing one. A safer solution seemed to repose among the Army's voluminous regulations, notably Army Regulation 5-240, which prescribed that whenever a manufacturer held a patent or was the sole source for an item, no competition was needed. The subterfuge worked. Between 1926 and 1934, besides spending well over $16 million in experimental contracts, procurement officers negotiated non-competitive, sole-source contracts amounting to more than $22 million. The combined spending of nearly $40 million in about eight years was helping revive the aircraft industry, until *The Washington Post*, in January 1934, accused the War Department of wrongdoing in procuring aircraft for the Army Air Corps without competition. The deepening economic depression had undermined the stature of businessmen and raised questions about the ethics of those who provided their profits, including the Air Corps. Congress responded to the mood of the people and launched an investigation which revealed that Air Corps procurement officers allowed a 15-percent margin of profit in negotiated contracts.[13]

Although most of the newspaper accusations of favoritism ultimately proved false, Congress insisted anew on competition for contracts. Bowing to legislative authority, War Department officials in late 1934 established a new procurement policy. Every bid, whether for the procurement of individual experimental aircraft or for production in large quantities, now had to be accompanied by a completed "sample" aircraft. To standardize samples, facilitate testing, and improve the quality of competition, bidders had to use government-furnished equipment (GFE)—instruments, armament, oxygen, communications, and other items interchangeable among different airplanes. Air Corps procurement officers also gave prospective bidders listings of federal specifications for materials and subassemblies. The new policy encouraged bidders and, as a rule, produced new aircraft that outperformed those currently in use by the Air Corps. Yet, the basic procurement problem, measuring cost against performance, remained unsolved.[14]

If a manufacturer knew that his sample aircraft enjoyed overwhelming technical superiority, he could inflate his price and profit unreasonably; yet, the best aircraft could be the most expensive, even though its price had not been inflated. In 1936, following submissions by Douglas, Curtiss-Wright, and Fairchild of fully acceptable bids and samples for a transport aircraft, the Air Corps awarded the production contract to Douglas, whose entry was a twin-engine transport already in production, the DC–2, precursor of the famous DC–3, or C–47 of World War II fame, and twice as costly as the single-engine transports offered by the other two competitors. Actually, the DC–2 was vastly superior, but just the same, Fairchild complained about the cost differential. Upon investigation, the Comptroller General ruled that the Douglas sample had indeed won the competition, solely in terms of technical performance, but offered the principle that, when competing for production quantities of aircraft, there could be "no proper evaluation" when price was disregarded. The Secretary of War, on the other hand, argued that Section 10 of the Air Corps Act of 1926 gave him authority to discount the cost factor in awards that best served the interests of the Air Corps. In short, the War Department believed that the need for aircraft of superior performance to defend the nation took precedence over price.[15]

The conflicting views of the Comptroller and the Secretary of War underscored a bureaucratic problem, inasmuch as the Comptroller General served as the agent of Congress and the Secretary of War acted on behalf of the President. If either had chosen to take his case to his superior, a clash might have arisen between legislative and executive departments. Fortunately, Congress readily provided a solution, simply deciding that such

conflicts could be settled by the Attorney General. In the case of the new Air Corps transport, the Secretary of War won out, and Douglas eventually got paid.[16]

The outcome of the Douglas episode reminded the War Department that the Comptroller General ultimately held the purse strings. Furthermore, if procurement officers expected their programs to move forward, they also had to avoid antagonizing the General Accounting Office (GAO), the investigative arm of Congress. Moreover, Representative McSwain, who had become Chairman of the Military Affairs Committee, had not relented in his demand for competition—even when purchasing a single experimental plane. Once again, the War Department had to revise procurement policy. To satisfy the Comptroller General, an ingenuous formula was contrived: a figure of merit, determined on the basis of performance, was divided by the cost set forth in the manufacturer's bid. The resulting price factor thus favored the bidder who could combine the lowest price with the highest performance. To satisfy the GAO, the new policy returned to the use of paper design competitions even for the purchase of experimental aircraft.[17]

War Department officials were quick to boast about the procurement policy they revamped in 1935, but Air Corps officers showed little enthusiasm for it. Indeed, as far as experimental aircraft were concerned, the policy had been tried out in 1927 and found unworkable. There was no reason to believe that the failed policy would fare better now, and on the few occasions it was applied, it did not. As before, the design competition for experimental aircraft tended to yield meaningless promises. When it came to production contracts, the revamped policy required that sample aircraft be acquired through design competition and then tested in an aerial competition.[18]

As anticipated by Air Corps officers, competition among sample aircraft proved difficult to administer. To begin with, the procedure involved mailing a circular specifying the terms of the minimum acceptable performance. The sample aircraft's maximum performance was not defined, putting more pressure on the competitors, whose products had to exceed the minimum by the greatest possible margin. To ensure fairness and prevent favoritism, procurement officers ruled that after a manufacturer entered a competition, the aeronautical engineers at Wright Field were barred from offering any help whatsoever. The decision seemed fair, but it drove up costs because design improvements could not be suggested when the sample aircraft was in the mockup stage, and flaws could be identified only after the plane had been flown to Wright Field for evaluation. In other words, failings that might have been prevented cheaply in the early stages of development had to be corrected later on at greater expense.[19]

Like the Air Corps, but for different reasons, aircraft manufacturers disliked the procurement revisions of the mid-1930s. The growing complexity of aircraft increased manufacturing costs, and the submission of a good sample aircraft by no means guaranteed success in the competition and the ensuing reward of a production contract. In fact, during these lean depression years, brokers involved in raising capital for the aircraft industry often warned their clients that some manufacturers avoided entering such competitions for fear of losing their whole investment in the sample aircraft. By 1938, competitors had become so scarce that the War Department endorsed a costly Air Corps suggestion that the government purchase not only the winning aircraft, whose manufacturer would receive a production contract, but also the two runners-up. Despite this effort to subsidize the competition, at least partially, problems remained.[20]

First, the two runners-up, after being flight-tested might not be deserve a production contract. In such cases, the planes became experimental aircraft, and the manufacturers would receive a negotiated sum that might not even cover the sample aircraft's construction

costs. Moreover, money for the runners-up would have to come from a limited Air Corps research and development budget, even though the sample aircraft, having been built to definite specifications, might be useless for general research. Worse, any appropriations earmarked for producing quantities of the runners-up might remain unspent, and Congress, instead of viewing the result as evidence of economy, could jump to the conclusion that the Air Corps's production estimates had been padded.[21]

In October 1938, the Air Corps again changed its procurement procedure. Before submitting circular proposals for aircraft in quantity, the Air Corps now invited manufacturers to submit designs for evaluation. Then, one or more promising designs would be awarded experimental contracts for the construction of one or more test aircraft. However, detailed specifications would not be prepared for possible quantity procurement until after the design winner or winners passed the final mock-up stage. This would allow Air Corps officers to talk to manufacturers and suggest changes during the aircraft's construction, without being accused of favoritism. In short, the new policy promised quantity procurement based on objective evaluation of actual performance. Initial costs would rise, but significant savings could be expected to follow since the number of contract amendments would be greatly reduced.[22]

The World War II Production Boom

Application of the revised policy of October 1938 was overshadowed by the impending Second World War and President Franklin D. Roosevelt's buildup of the air arm. The Air Corps, from the start, faced a seemingly impossible task. Because of the inability of the aircraft industry in mid-1939 to produce large numbers of airplanes, the government decided to build immediately at least four factories, each one potentially capable of manufacturing a yearly average of 1,200 aircraft. These government-owned standby facilities, called air arsenals, were planned for: Ogden, Utah; Denver, Colorado; Dayton, Ohio; and Harrisburg, Pennsylvania, with three additional sites to be selected. Production would take place under private management using privately developed designs; only the facility would be government-owned.

The manufacturers, however, immediately opposed the government's involvement in production on the grounds that it might lead to nationalization of the entire aircraft industry. This reluctance, as well as ensuing shortages in labor, material, and other resources, did not stop the program. The government supplied machine tools and entire factories, placing them at the disposal of the aircraft manufacturers. Production became the watchword, exceeding the most optimistic estimates, but, inevitably, there was a price to pay.[23]

Remembering the excessive profits of the aircraft manufacturers during World War I, Congress refused to return to the use of the CPPC contracts and in 1940 only reluctantly authorized the cost-plus-fixed-fee (CPFF) contract, which allowed a 7-percent maximum profit in aircraft procurement. Yet, after the Japanese attack on Pearl Harbor, speed and volume of production took precedence over economy. As a result, procurement officers began hurriedly signing contracts, whether fixed-price or CPFF instruments, accepting without challenge cost figures sufficiently inflated to protect hesitant manufacturers from any possible losses. In effect, manufacturers were naming their own price, and the Air Corps was accepting it.[24]

The hastily drawn contracts resulted in profits so outrageous that Congress enacted the Renegotiation Act of 1942, which empowered department heads to renegotiate contracts that seemed exorbitant. The new legislation called for stiff penalties, and some

manufacturers, perhaps in the hope of securing more easily other lucrative government contracts, volunteered refunds. Nevertheless, the Air Corps still confronted contracting problems of great complexity. For example, the contractor's free use of government facilities became a factor in determining whether a firm was making excess profits. Segregating overhead expenses proved difficult whenever a manufacturer used a single plant to satisfy several different types of contracts. The post-production modification of aircraft also proved troublesome and often ridiculously expensive. Indeed, some officers believed that too often the manufacturers used major airline maintenance centers, leased by the government after January 1942, to accomplish so-called modification work that should have been done at lesser cost on the production line. Finally, contract termination, which occurred occasionally in wartime when planes underwent radical modification or were replaced by new models, became an acute problem upon demobilization at war's end.[25]

The costly confusion of demobilization and the fiscal restraints in force immediately after World War II period also impeded orderly action. These considerations, along with the pre-war and wartime investigations of a special Senate group that he headed, most likely accounted for President Harry S. Truman's preoccupation with military procurement, a concern which resulted in the passage of the Armed Services Procurement Act of 1947. The procurement law went into effect after President Truman approved the National Security Act of 1947 that, among other things, set up the United States Air Force as a component of a National Military Establishment. The Armed Services Procurement Act established uniform contracting policies and procedures for all components of the new defense department. These rules appeared in the Armed Services Procurement Regulations (ASPR), which numbered some 125 pages in 1947 but grew to more than 3,000 in 25 years. Unfortunately, the end of World War II generated other problems far more critical than disorder and waste.[26]

The short-lived euphoria of victory gave way to the tensions generated by the emergent Cold War, which lasted some 40 years and exacted a high toll in men and money. In 1945, it seemed at least technically possible for the United States, the sole possessor of the atomic bomb, to impose its will upon the rest of the world. However, the Soviet Union developed its own atomic weapons, however, and an arms race ensued between the two powers, during which the United States shouldered responsibility for supporting nations opposed to communism while at the same time safeguarding the national interest.[27]

Facing the overwhelming manpower of the Soviet Union and Communist China, the United States relied on strategic deterrence, which sought to offset numbers with the threat of nuclear and thermonuclear firepower unleashed by air against an enemy's society. At least until the 1960s and the advent of the intercontinental ballistic missile (ICBM), deterrence depended on the strategic bomber. The Truman administration, like the subsequent administration of Dwight D. Eisenhower, tried to maintain controls over military budgets, despite the Cold War. Hence, the newly independent Air Force found itself in a quandary, caught between limited appropriations and inflexible priorities. Although pressed for money, the air arm had to spend massive sums to modify numerous B–29s, acquire the B–50 (based on the B–29D Superfortress), procure a few C–97 transports (another variant of the Boeing B–29), proceed with development of the Convair B–36, and reconfigure various other aircraft involved in supporting the atomiC–capable bombers. Whatever the cost, the deterrence took precedence over all other missions.[28]

Despite its commitment to strategic air warfare, the Air Force could not simply ignore the unglamorous transport; but, because there was not enough money for all functions, military airlift became the job mainly of a few aircraft developed for World War II, supplemented by leased civilian aircraft, Indeed, airlift had been a similar stepchild of

strategic and tactical aviation during World War II, even though factories delivered 14,000 transports in three years, most of them based on prewar commercial types. For example, the C–47 evolved from the Douglas DC–3, the C–54 from the Douglas DC–4, and the C–46 from the Curtiss-Wright CW–20, though the B–24 bomber inspired a transport, the C–87, and a fuel carrier, the C–109, that supplied B–29s based in China. As the Cold War soon demonstrated, airlift, with its patchwork fleet of aircraft, was important enough to require efficient administration and employment. To accomplish these ends, Secretary of Defense James V. Forrestal created the Military Air Transport Service (MATS) on June 1, 1948.[29]

Airlift for Berlin and Korea

After the end of World War II, the victorious allies divided a defeated Germany into four zones of occupation, one each for France, Great Britain, the Soviet Union, and the United States. Within the Soviet zone of occupation, Berlin, the German capital, underwent a similar division into four occupied sectors. In June 1948, following a decision by the western allies to unify their zones of occupation into a single economic and administrative unit, Soviet officials began harassing traffic between the western occupation zones and the western sectors of the city. In response, Air Force Douglas C–47 Skytrains and Royal Air Force Douglas Dakotas of World War II vintage started airlifting food and supplies to the allied garrisons in the isolated city using three air corridors established in 1945 for safety reasons.

On June 24th, the Soviet government terminated all surface traffic from the western zones of occupation. The blockade of the city was complete. A large-scale airlift, eventually known as Operation Vittles, got underway two days later when Army Gen. Lucius D. Clay, the American military governor of Germany, ordered Lt. Gen. Curtis E. LeMay, commander of the United States Air Forces in Europe (USAFE), to resupply the people of Berlin through the air. LeMay entrusted the operation to Brig. Gen. Joseph Smith who immediately began making use of the roughly one hundred C–47s available in Germany. Knowing that these would be inadequate for the job, LeMay also asked for and received four squadrons of four-engine Douglas C–54 Skymasters. At the same time, the Royal Air Force its own airlift, called Operation Plainfare, initially using Dakotas reinforced later by four-engine Avro Yorks.

In late July 1948, about one month after LeMay began the airlift, the Air Force decided that further expansion was necessary and ordered Maj. Gen. William H. Tunner, an airlift expert of proven ability and a deputy commander of MATS, to Germany to take charge of the U.S. airlift operations. On 15 October 15, 1948, Operation Vittles and Operation Plainfare were united by the creation of the Combined Airlift Task Force (CATF) under General Tunner with Air Commodore John W. F. Merer as his deputy. Although not in direct operational control of the Airlift, the Military Air Transport Service trained replacement air crews, deployed aircraft, and manned them, all the time trying to find enough airlift to continue routine operations. The Air Force let contracts to commercial air carriers to take over some of the transatlantic flights.

Tunner and his staff wasted no time adapting the lessons they had learned while conducting the wartime airlift between India and China, crossing and recrossing the "Hump," as the rugged Himalayan mountains were known. He exchanged the C–47s for larger C–54s, streamlined the size and complexity of the airlift support system, built new runways and a new base in Berlin, and most important, enhanced efficiency through a number of management innovations. Thanks to increased numbers of larger aircraft and the more efficient operations, the volume of supplies flown into Berlin increased dramatically within

weeks of his arrival. Tunner and his staff quickly created an aerial bridge with one aircraft landing every three minutes, a level of sustained effort that made the maximum use of all his available resources.

Besides the Royal Air Force's substantial contribution, transport aircraft of the United States Navy joined the airlift in November 1948. The Navy also shipped aviation gasoline across the Atlantic along with food drawn by the Army from the surplus stocks maintained by the Department of Agriculture, and additional naval air transport units ferried engines, spares, and personnel to Germany. The U.S. Army was responsible for managing, transporting, and handling of cargo to the airlift airfields, loading the cargo for the flight into Berlin; unloading the cargo after its delivery; and its distribution to supply points throughout the city.

As soon as the Soviets began the blockade, American and British diplomats sought to resolve the crisis through negotiation, even meeting with Joseph Stalin in person. They had little success at first. The Soviet leader believed that the airlift would fail, and placed his faith in the implacable weather of winter in northern Europe. Only when winter came and the airlift continued to operate—and to expand its deliveries—did Stalin change his mind and settle with the western powers. On May 19, 1949, the blockade ended. To make sure that the Soviet Union would not reinstate the blockade once the airlift task force disbanded, the western powers continued airlifting food and coal until the end of September 1949, building up an emergency reserve capable of meeting the needs of 2,500,000 Berliners in case the Soviets blockaded again.

The success of the Berlin Airlift enabled the United States and Britain to resist Soviet pressure without precipitating a shooting conflict. The effects of this victory were far reaching. The Berlin crisis of 1948 hastened the creation of an independent, democratic West Germany, and was instrumental in the establishment of the North Atlantic Treaty Organization. It also preserved a vital outpost of Western influence far behind the Iron Curtain. For the U.S. Air Force, Operation Vittles demonstrated that the military air cargo fleet needed modernization. For example, it would require 178 Douglas C–54s, flying 13,800 round trips per month, to deliver 135,000 tons into Berlin. Had the larger Boeing C–97 been available, 51 of these aircraft could have carried the same weight of cargo in only 5,870 sorties per month.[30]

Breaking the blockade of Berlin did not result in the procurement of much-needed new transports. Instead, on June 25, 1948, one week after the beginning of the blockade, Air Force Secretary W. Stuart Symington and other top Air Force officials unanimously agreed to continue the expensive program to develop the B–36 strategic bomber. Until air-refuelable, jet-powered bombers became operational, only the B–36 with its intercontinental range, high operating altitude, and vast bomb load, could truly deter an enemy through fear of atomic retaliation.[31]

The emphasis on deterrence seemed well-founded when the Soviet Union in 1949 exploded its own atomic bomb; but the strategy of deterrence did not prevent aggression on the Korean peninsula, divided between the communist North and American-supported South Korea. On June 25, 1950, in a surprise attack, North Korean infantry, spearheaded by Soviet-built tanks, invaded the Republic of Korea. The conflict that ensued was fought under the auspices of the United Nations, but the American armed forces took the lead in repulsing the aggression of first the North Koreans and then the Chinese communists, who late in 1950 intervened on behalf of their ally.[32]

Nuclear weapons neither deterred nor won the Korean War. The policy adopted by the United Nations and the United States in the winter of 1950 after the Chinese intervention

called for resisting aggression, maintaining the independence of the Republic of Korea, and ending the hostilities on acceptable terms. This policy made sense in terms of air power because the Air Force in 1950 faced global responsibilities for which it was as yet ill-prepared. The low rate of military aircraft procurement in the postwar years left the industry incapable of quickly satisfying new requirements; airplanes lost in a major war could not be replaced within an acceptable time. Therefore, should the United States become involved in such a conflict, the operational fleet of aircraft could be dangerously depleted. Likewise, the atomic stockpile remained so small that the use of such weapons in the Korean conflict would have undermined the American deterrent. Moreover, the available atomic weapons were not yet compact enough for tactical use, and, unlike the Soviet Union, Manchuria and even China afforded few lucrative strategic targets.[33]

The Korean armistice, signed on July 27, 1953, put an end to the fighting on terms acceptable to both the United Nations and the United States, leaving North and South Korea facing each other across a narrow demilitarized zone. Whatever the results on the Korean peninsula, the war had prompted a significant increase in the military budget, bringing the total amount appropriated for the Department of Defense for fiscal year 1951 to $48.2 billion, a jump of $34.9 billion from the previous fiscal year. The fledgling Air Force prospered. Its strength, fewer than 50 wings and less than half a million military personnel when the conflict started, was authorized almost to double in size. In November 1951, as the world situation seemed to worsen, the Joint Chiefs of Staff authorized a further expansion of the Air Force to 143 wings and 1.2 million military personnel by the year 1955. Even though these numbers were subsequently reduced, the decision of the Joint Chiefs decision had a permanent impact, ending the practice, followed since the end of World War II, of awarding each of the military services a roughly equal share of defense appropriations. The Army's budget now shrank to about 22 percent of the total, the Navy received 29 percent, but the Air Force got the rest.[34]

The Air Force's expansion in manpower was accompanied by significant increases in aircraft procurement, which rose from 1,200 airplanes in fiscal year 1950 to over 8,500 in fiscal year 1951. Few of the new orders, however, were filled before the 1953 armistice. During the first weeks of the communist invasion, when American rearmament was barely under way, the Far East Air Forces (FEAF) committed most of its Japan-based Fifth Air Force to the conflict and established air superiority over Korea, which it maintained throughout the fighting.[35]

Despite some major accomplishments—especially during the fighting in December 1950 near the Chosin Reservoir, when cargo planes evacuated the wounded and parachuted a bridge to help American marines break out of a Chinese encirclement—the Korean War did not improve the prospects of military airlift. General Tunner, Deputy Commander of the Military Air Transport Service, received orders in September 1950 to organize a Combat Cargo Command (Provisional) for the Fear East Air Forces. Tunner's unit handled all kinds of airlift, including landing supplies and troops and parachuting combat troops, equipment, and supplies. From the outset, Tunner faced a bleak situation. Prior budgetary restrictions and the resulting suspension or slowing of worldwide activities had seriously and adversely affected the Military Air Transport Service and the airlift elements of the Far East Air Forces. Whereas civilian airlines operated their planes eight to twelve hours a day and maintained three crews or more per plane, the utilization rate of MATS transports, which provided strategic airlift during the war in Korea, had dropped to 2.5 hours per day per airplane, with but one crew per aircraft. Pilots, maintenance crews, equipment, stocks of parts, and facilities had been drastically cut. Moreover, except for the Fairchild C–119, the

only aircraft available were the same old transports that had broken the Berlin blockade. Consequently, the airlift contributions, including the life-saving aerial evacuation of casualties to Japan during the Korean fighting, required the costly help of commercial airlines.[36]

General Tunner faced other problems during the war. To complement FEAF's two groups of C–54s and C–119s, as well as the numerous C–47s already in the area when the hostilities started, the Air Staff in the Pentagon immediately sent to the war theater all available troop carriers—about 250 planes, mostly C–119s. Tunner appreciated the twin-boom C–119, which evolved from the C–82, the first Air Force plane designed expressly as a military transport. The C–119 was new, however, and still had its share of bugs, especially with the propellers. On the positive side, the rear-loading C–119 Flying Boxcars could carry howitzers, trucks, light tanks, and other equipment. The C–119s proved valuable indeed, since each aircraft could either deliver cargo or drop as many as 65 paratroopers.[37]

Although he liked the C–119, when the Air Force ordered more of them, Tunner objected because all were to be equipped to parachute men and equipment. The extra weight of the overhead bar (to which the parachute ripcords were attached) and the heavy structural bracing that supported the bar, significantly reduced the tonnage of cargo the aircraft could carry. Twenty percent of the C–119 fleet, equipped for airdrop, would have been more than sufficient to take care of existing requirements, Tunner argued. Moreover, the lighter C–119s, with their greater payload, would have speeded the movement from Japan of thousands of tons of cargo vitally needed in Korea.[38]

Tunner voiced other criticisms of military airlift. Transport planes were scattered among various commands of the Air Force, and among the Navy and Marine Corps, all of which had different utilization standards that bred duplication and waste. If these aircraft could not be consolidated into one operating command, at least all air transport organizations within the Air Force could be merged. The Air Staff seriously considered consolidating air transport and troop-carrier aviation—long-range and battlefield airlift—but gave up on it when the Army and the Tactical Air Command (TAC), which controlled all Air Force tactical transports, expressed bitter opposition. Army leaders believed, and those at TAC concurred, that troop carrier units were combat outfits that could not be combined with long-range passenger and cargo service to form a single air transport command.[39]

In addition, the Korean War revealed confusion over the roles and missions of the Air Force and Army aviation that led to the Pace-Finletter Agreements of 1951 and 1952. Secretary of the Air Force Thomas K. Finletter and Secretary of the Army Frank Pace divided airlift responsibilities, prohibiting the Army from acquiring and operating aircraft for transporting airborne troops into combat, reaffirming weight limits on the Army's fixed-wing aircraft, and clarifying aeromedical evacuation duties, with the Air Force removing casualties from the combat zone and the Army moving than to treatment stations within the combat zone.[40]

The conflict in Korea also led to the creation of the Civil Reserve Airlift program, whereby certain commercial transports could be drafted, rather than leased individually, to augment the military airlift fleet. Not until the war against Iraq, more than thirty years later, did the Air Force and the airlines cooperate in using this program.[41]

Although the Korean struggle did not change the basic organization of military airlift, it clearly emphasized the importance of air transport. The Air Force Chief of Staff, Gen. Hoyt S. Vandenberg, declared that the best armed strategic striking force would be neither strategic nor effective, if deprived of logistics. Prestocking critical supplies in overseas bases impressed him as expensive as well as risky, since it committed strategic bombers to operate

from bases that might be denied them at the outset of war. "Logistics must be as strategically mobile and flexible as the forces it supports," General Vandenberg said, and the airlift forces should be able "to move logistic support with and as the bombers move." The Army Chief of Staff, Gen. J. Lawton Collins, without belittling the importance of tactical airborne operations, began insisting that the Army should be made as air transportable as possible over great distances. The demands voiced by General Collins would be repeated for years to come, but the idea was hardly new to Air Force leaders. Back in December 1945, Theodore von Kármán, Director of the Army Air Forces Scientific Advisory Group, urged Gen. Henry H. Arnold, Commanding General of the Army Air Forces, to make the aerial transportation of entire armies one of the air arm's principal goals for the coming decade.[42]

War, be it limited or worldwide, affects procurement. In the rush to mobilize, costs soar and regulations fall by the wayside. Officials abandon the time-consuming competitive process in favor of the faster negotiated contract, much preferred by the defense industry because of the potential for great profit. Modification centers like those of World War II, although still staggeringly expensive to operate, functioned during the Korean conflict until the practically dismantled aircraft industry could cope with the nation's new requirements. Costly though they were, the centers may have proved worthwhile. For example, they enabled Republic Aviation Corporation to incorporate a weekly average of 315 modifications in crucially needed, Korea-bound F–84s. Yet, even in the midst of war, Congress did not hesitate to condemn strongly all procurement excesses. "Some way must be found," the House Committee on Appropriations declared, "to shock the people in the Department of Defense from top to bottom into the full realization that the Congress and the American people will not tolerate flagrant waste in money and manpower."[43] Consequently, the Air Force's appropriations for fiscal year 1953 were reduced by $l.6 billion, but most of it was restored in mid-1952.[44]

Not only did the Air Force regain most of the original funding for fiscal year 1953, its subsequent military budgets, despite economizing by the Eisenhower administration, grew from year to year. As early as 1950, with Truman still in the White House, a buildup of the defense department had become unavoidable. That year's invasion of South Korea—and the subsequent fighting that brought China into the war and resulted 33,629 Americans killed and 103,284 wounded—demonstrated the need to maintain strong and ready forces. Moreover, on the heels of the Korean armistice, the Soviet Union tested a thermonuclear weapon, and by mid-1954 the Joint Chiefs of Staff calculated that the Soviets would soon possess a stockpile of atomic weapons sufficient in size to mount a devastating attack against American military installations, industry, and population centers.[45]

Continuing Wartime Aircraft Procurement Practices

As far as Air Force leaders were concerned, the increasing Soviet threat meant that industrial mobilization had to achieve a level that would permanently assure adequate production. In other words, the capacity resulting from the Korean war—when Congress appropriated $2.2 billion for the acquisition of land, buildings, and machine tools—would survive to the fullest extent consistent with overall economic considerations. In carrying out this policy, the Air Force gave priority to retaining facilities that supported contractors having special design and development capabilities, and to those with dual-purpose plants that could be expanded rapidly. In addition, Air Force officials decided that, whenever possible, contractors with a limited production capacity would have an opportunity to participate in maintenance and modification programs. As often done during the Korean

conflict, the Air Force would assist firms wishing to obtain loans from the Reconstruction Finance Corporation (RFC) and certificates of necessity for accelerated tax amortization. Finally, reserves of machine tools and other production equipment, allocated on a priority basis to defense contractors, would be modernized and stored in more accessible locations.[46]

The nation remained neither at peace nor at war, and the national emergency declared by President Truman during the Korean hostilities remained in effect decades later. Hence, despite the armistice that ended the fighting, procurement activities continued to benefit from the legislative exceptions normally allowed only in wartime or when war became imminent. As a result, the so-called incremental progress payments authorized by the War Department on the eve of World War II to help aircraft manufacturers over the financial hazards of new production, having been reinstituted during the Korean conflict, became a normal element of the procurement process. Briefly stated, progress payments acknowledged satisfactory work already completed, rather than serving as advances in anticipation of future work, and they could not exceed 80 percent of the total cost under the contract. The demands of the Cold War justified this departure from the old procurement practices. [47]

The first deviation from accepted procurement procedures involved the abolition of the practice of testing various prototypes before choosing a contractor for development and production. Air Force leaders of the 1950s believed that the "fly before you buy" concept (to be reintroduced many years later with great fanfare) took too long. Lead-time from development to operational use, they argued, had to be reduced to take advantage of rapid technological advances. In theory, the decision appeared sound; in application, it created monumental problems. During the late 1950s and early 1960s, development and production programs, if not totally concurrent, often overlapped. In such cases, the contractors faced so many uncertainties that they refused to agree to firmly fixed prices. This all but forced the government to reduce contractor risks with two types of contracts—cost-reimbursement and cost-plus-incentive. The first placed a heavy administrative burden on both the government and the contractor; the second merely encouraged the contractor to improve his management practices.[48]

Reorganizing to Manage Technology

As early as 1945, the air arm, while still a part of the Army, tried to untangle research and development from procurement and supply. The frustrating, seemingly endless problems in procurement cannot be attributed to a lack of determination on the part of the Army Air Forces—and later the Air Force—to keep up with rapidly changing technologies. General Arnold, at von Kármán's suggestion, established in the Office of the Army Air Forces Chief of Staff a separate R&D agency, known as the office of Deputy Chief of Staff (DCS) for Research and Development, under Lt. Gen. Curtis E. LeMay.[49]

R&D had been a subordinate part of the production process and firmly in the hands of the materiel specialists since 1907, when the Army Signal Corps Aeronautical Division was established. Although administrative or other changes occurred over the years, none had the significance of the organizational events that took place in 1950. On February 1, the Research and Development Command was organized as a major command and redesignated Air Research and Development Command (ARDC) on September 16, becoming the equal of the Air Materiel Command (AMC). AMC retained responsibility for procurement and supply, while the ARDC dealt with research and development. Tradition died heard, however, and the new AMC persisted in stockpiling war-ready materiel and emphasizing quantity rather than quality. The outbreak of war in Korea obscured the relationship between development

for the future and procurement now, since badly needed aircraft went into mass production regardless of cost or approaching obsolescence, thus postponing difficult decisions.[50]

Bureaucratic tensions notwithstanding, ARDC quickly proved its worth. In the spring of 1952, more than 1,500 research contracts awaited review, all of which covered aspects of the most advanced aeronautical technology of the day. For example, ARDC wanted to find out the effects of supersonic speeds on aircraft design, and how to banish "clutter" from radar images while improving identification capabilities. The command and its laboratories promoted research on a myriad of crucial projects, such as incorporating titanium and plastics in airplane construction, increasing the propulsive power of rocket and turbojet engines, and developing the digital computer for use in weapons guidance and control systems.[51]

In August 1952, it became evident that progress in research and development fell short of the Air Force objectives. Reliable intelligence reports indicated that within a few years, perhaps as early as 1956, the Soviet Union could have in its arsenal nuclear warheads weighing up to 2,000 pounds that could be delivered by two-stage rockets with range enough to reach the northeastern United States. The race to perfect an intercontinental ballistic missile (ICBM) was beginning sooner than anticipated. Some high-ranking Air Force officers had already discussed how to accelerate ICBM development, but their recommendations went unheeded. Late in 1952, Lt. Gen. Laurence C. Craigie, DCS/Development on the Air Staff, after convening a committee of the Scientific Advisory Board, endorsed retention of the old method of sequential acquisition, whereby each weapon system was developed one step at a time, with the initiation of each phase depending on the success of the previous one.[52]

Despite the pressure of events, not until 1954 could the ARDC convince the Air Staff and the Department of Defense that the time-tested but time-consuming practice of sequential acquisition had to be replaced. Change resulted, however, from the unanimous recommendation of the prestigious Teapot Committee. Trevor Gardner, who had served in the wartime Office of Scientific Research and Development and in 1953 became Special Assistant to Secretary of the Air Force Harold E. Talbott for Research and Development, selected the group, which Dr. John von Neumann, a renowned mathematician, headed. Neither Gardner nor the committee he chose believed that the Air Force's step-by-step approach to aircraft development would work for ballistic missiles. The new and preferred mode of weapon system acquisition, known as "concurrency," called for development of many subsystem components at the same time. To accelerate development of the ICBM, the committee recommended concurrent development of missile configurations, propulsion systems, and other components, along with concurrent acquisition of test facilities and field installations.[53]

The Air Force decision to speed development of the ICBM and to endorse ARDC's new procurement procedures resulted, at least in part, from the Soviet Union's detonating a thermonuclear device in August 1953, only ten months after the United States tested its own prototype of this weapon. In mid-1954, at Trevor Gardner's insistence, the program to develop an ICBM received an overriding priority, and every effort was made to ensure an initial operational capability (IOC) in 1960, only six years away, a formidable task requiring dramatic action. Air Force leaders terminated the existing missile program and started a new ICBM project. The eminent civilian scientists associated with the Teapot Committee recommended new technical objectives, massive funding, and centralized management, which would combine to speed the development process. To direct the streamlined program, the Air Staff created the Western Development Division headed by Brig. Gen. Bernard A. Schriever.[54]

The ICBM development program, successful though it turned out to be, proved extremely expensive because concurrency, which most likely accounted for the program's swift

progress, also compelled the Air Force to invest in duplicate approaches—both components and entire weapon systems—to ensure that at least one succeeded. In any case, applying to other projects the procedures that governed the unique, high-priority ICBM program would prove difficult if not impossible. A prominent feature of the concurrency concept was the delegation of managerial authority for any given weapon to an integrated Weapon System Project Office, even though the research and development and procurement functions remained vested in two separate commands. Delegating decentralized authority across the boundaries of the two commands, as General Schriever did for ICBM development, ran counter to institutional norms.[55]

After taking over ARDC in March 1959, and being promoted to lieutenant general the following month, Schriever became convinced that the Air Force, present and future, would best be served by dividing acquisition and logistics into two commands: one for research and development, production, and procurement; and the other, separate and coequal, for logistics support. People engaged in weapons acquisition, Schriever reasoned, developed analytical patterns of thought and learned to live with calculated risks; logisticians relied on tried, conservative methods—two incompatible mindsets.

The advent of the Kennedy administration, which decided to award the Air Force responsibility for all military space research, enabled Schriever to carry out his plan. On April 1, 196l, the Air Materiel Command was reorganized as the Air Force Logistics Command (AFLC), and the Air Research and Development Command became the greatly enlarged Air Force Systems Command (AFSC). General Schriever received his fourth star and began adapting to his new command the principles which he had pioneered in the ICBM program.[56]

Contract Changes Add Costs

Meanwhile, an onerous and perhaps inescapable problem remained. Weapon systems, be they prototypes or production articles, rarely reached the operational inventory without undergoing change, either absolutely required or merely desired. Either the weapons did not work as expected, and therefore needed modifications, or additional requirements materialized before or by the time they became available. Regardless of the cause, the Air Force ended up paying dearly, and concurrency, by emphasizing duplication, compounded the problem. In late 1970, the Rand Corporation would actually report that the typical effect of contract changes was to increase costs by approximately 40 percent, a conclusion based on the analysis of ninety-four Air Force contracts.[57]

Evolving technology and a changing Soviet threat conspired to prevent the Air Force from freezing designs early in the procurement process and thus saving money. Technically, every change order called for a supplemental agreement to the basic contract, but a single change order seldom warranted the time and expense of an exclusive negotiating session, so that as many as fifty change orders could be covered by a single supplemental agreement. Moreover, a simple change order could very well include several engineering changes. Unfortunately, procurement officers and comptroller personnel rarely had any basis to gauge the incremental value of changes and the added resources required to accomplish the work thus authorized. Nor were they willing to increase costs or delay program schedules by postponing changes, which program officials commonly designated as urgent. Hence, the law that appeared to favor the government, in practice, generated substantial contractor profits.[58]

The problems caused by change orders intensified in the 1950s, as weapon systems became more sophisticated. All too frequently, the more complex a system tended to be, the

more changes it required. That contractors increasingly proposed such changes came as no surprise. Usually, the work required by change orders was completed or nearly completed before negotiation of a supplemental agreement to the basic contract. This gave the contractor no incentive to control costs, since the eventual price of the incurred changes would be based not estimates, when the contractor's negotiating position was weakest, but on actual expenditures. In short, change order negotiations tended to take place after the fact, when it was too late for the government to bargain, or occurred in a sole-source environment, where it was all but impossible to transfer the work to another contractor. Hence, an apparent government prerogative quickly became a favorite gambit of most contractors. Taken to the extreme, the change orders allowed contractors to secure contracts with totally unrealistic low bids, knowing that subsequent modifications would ensure that they not only recouped initial losses but made enormous profits.[59]

Airlift at the Close of the Eisenhower Era

In 1960, President Eisenhower's final year in office, the importance of airlift remained overshadowed by the power of atomic weapons and their possibly decisive use by the Air Force's strategic strike force. In fact, only two new transports, the Lockheed C–130 and Douglas C–133, actually entered service between the end of the Korean conflict and the beginning of the 1960s, joining the Douglas C–124, handicapped by four complicated piston engines, the Fairchild C–119, which had served in Korea, and the twin-engine Fairchild C–123, designed for that conflict.[60]

Continued neglect of the country's military transport aircraft did not, however, lessen the importance of the airlift mission. On occasion in the late 1950s, MATS contracted with civil airlines to satisfy even the limited airlift challenges presented by crises in Lebanon, the Far East, and other distant places. Yet, in spite of its sizable budgets, the Air Force faced the same dilemma every year. It had to decide between aerial strike forces and combat support forces, between those that had to be maintained regardless of cost and those that could be deferred with acceptable risk. Every year, strategic airlift appeared in the category of safely deferred.[61]

The status of airlift changed, however, after a new Army-sponsored strategic concept, flexible response, emerged in the final years of Eisenhower's second term to challenge the nation's reliance on nuclear might. The creators of this strategy, not yet adopted in 1960, envisioned a nuclear stalemate that would deter not only an all-out war but also the use of tactical nuclear weapons in limited conflicts because of the danger of escalation. The security of the United States, the Army believed, would in these circumstances depend on conventionally armed ground forces airlifted to meet threats anywhere in the world.[62]

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CHAPTER II

FLEXIBLE RESPONSE AND THE BEGINNING OF THE C–5A

Like Dwight D. Eisenhower, who preceded him in the White House, John F. Kennedy continued to fight the Cold War, though sometimes with different tactics. Kennedy shared Eisenhower's tendency toward confrontation in Latin America, and went far beyond his commitments in Southeast Asia, but he did not simply adopt the declared strategy of the Eisenhower administration. Whereas Eisenhower and his advisers spoke of deterrence and massive retaliation—going to the very brink of nuclear war to preserve the peace—Kennedy emphasized highly mobile conventional forces, some of them trained in counterinsurgency, that could fight limited wars, which would erupt from time to time during a period of nuclear stalemate. Despite the difference in emphasis, both risked nuclear war, though to varying degrees—Eisenhower over the survival of Taiwan and Kennedy when responding to the Soviet deployment of nuclear missiles to Cuba. Indeed, Kennedy pushed ahead with strategic missile programs, even as he invested in aircraft capable of deploying conventionally armed troops throughout the world, and Eisenhower, despite his close association with strategic weapons made some improvements in airlift.

In March 1961, during his first message to Congress on the topic of defense, Kennedy declared that U.S. military forces should be made strong and mobile enough "to prevent the steady erosion of the free world through limited wars." This statement resulted in the substantial augmentation of airlift, including within a few years the purchase from Lockheed-Georgia of the huge C–5A, which complemented the long-range C–141 and intratheater C–130. The C–5A, besides providing a key element of the Kennedy administration's policy of flexible response, corrected shortcomings that had existed for years. Whatever the failings Kennedy inherited, trends in motion before his inauguration foreshadowed the development of the new transport.[1]

The Effects of Flexible Response on Airlift Requirements and Doctrine

Airlift deficiencies, especially the lack of a long-range transport exclusively for bulk cargo, had long been known. As early as October 1948, Maj. Gen. Laurence S. Kuter, the first commander of the Military Air Transport Service (MATS), criticized the use of passenger transports to move cargo and called for a civil cargo aircraft intended primarily for commercial service but easily adapted to emergency military operations. Although General Kuter's demands were modest, and despite the lessons of the Berlin airlift and the Korean war, the aircraft industry did not develop the kind of commercial plane that Kuter wanted. Development of an "air freighter" did not attract the interest of the public or the commercial airlines. In fact, both the press and Congress questioned the need to modernize MATS.

The command's lack of clout may have resulted, in part, from the divided responsibility within the Air Force for airlift—MATS handling long-range missions, and the Tactical Air Command conducting intratheater operations such as dropping paratroopers. Moreover, the interests of MATS and the commercial carriers sometimes clashed. In the late 1950s, Representative Daniel Flood, a Democrat from Pennsylvania who tended to support the airlines, objected to modernizing MATS to do a job that, in his opinion, the commercial carriers could do better. Sen. A. S. "Mike" Monroney (D—Oklahoma), another strong advocate for the airlines, repeatedly urged that MATS have only a small fleet designed to carry outsized cargo or to carry cargo to remote areas. Senator Monroney also recommended

that the government give commercial carriers guaranteed loans to build a cargo fleet which would enable them to take care of most of the airlift requirements of the Department of Defense.[2]

Ironically, while Kuter's appeal for a long-range cargo carrier languished, the Army's concept of "flexible response" was beginning to gain momentum in influential circles, even among naval leaders, who in the past had wholeheartedly supported strategic deterrence, in which their service had a growing share. "Having reached the stage of mutual deterrence," Secretary of the Navy Thomas S. Gates declared in December 1957, "power to prevent limited aggression and to win limited war becomes decisive." Unimpressed by Gates's words and obviously speaking for his service as an institution, the Air Force Chief of Staff, Gen. Thomas D. White, immediately retorted that "just as nuclear delivery capability constitutes a deterrent to general war, so can this total fire power deter local war." General White thus underscored the Air Force commitment to strategic deterrence based on nuclear retaliation.[3]

The Defense Reorganization Act, signed into law on August 6, 1958, realigned the unified and specified commands and also repealed the authority of the service chiefs to command their respective forces. Against this background, on July 1, 1958, the Military Air Transport Service assumed responsibility for "Point-to-Point Airlift." Early in 1959, even though the unified and specified commands had yet to provide MATS with detailed airlift requirements, the Joint Chiefs of Staff agreed to take another look at the airlift studies prompted by Gen. Maxwell D. Taylor while Army Chief of Staff. On June 30, 1959, Taylor retired, but his successor, Gen. Lyman L. Lemnitzer, immediately asked for even more strategic airlift than Taylor had. Taken separately, the changes in command structure and the renewed interest in airlift might have gone almost unnoticed, but together they greatly speeded the development of strategic airlift, as an essential component of flexible response.[4]

Meanwhile, the tempo of airlift-related activities had accelerated. In December 1956 and March 1957, respectively, two Department of Defense directives (Appendix 5) clarified existing or spelled out newly acquired responsibilities of the Military Air Transport Services. For example, the Department of Defense defined the Air Force mission of providing airlift support to the Army to include the movement of personnel, supplies, and equipment to, from, and within the combat area. The Defense Department also directed that most of the heavy airlift—larger or longer-range than intratheater transports, and excluding those that flew courier missions, delivering a few passengers or small amounts of cargo—be transferred to MATS from the Tactical Air Command and the Navy.[5]

Following adoption of this limited approach to a single-manager concept, MATS military transport operations were financed by a revolving fund, to which each military service made payment for services rendered. Most routine or administrative transport operations devolved upon the commercial airlines. In 1960, MATS scrapped the traditional method of competitive bidding and began negotiating contracts with civil airlines, using the rate floors prescribed by the Civil Aeronautics Board—a procedure obviously more lucrative for the airlines. The new arrangement came with a price, however, for all MATS contractors had to commit themselves to support the Civil Reserve Air Fleet (CRAF). Moreover, all airline aircraft earmarked for the CRAF had to be up-to-date cargo planes or passenger planes readily converted to carry cargo, a requirement that facilitated the upgrading of the industry fleet.[6]

During 1959 and 1960, General Tunner tackled the problem of obtaining the aircraft needed to modernize MATS, which he commanded. His first proposal called for a MATS fleet consisting of three types—a versatile work-horse transport, a carrier of outsized cargo, and a fast jet passenger craft. Satisfying his proposal's last requirement should pose no great problem, Tunner believed. Buying off-the-shelf any one of three commercial jets (either the Boeing 707,

Douglas DC–8, or Convair 880) would be relatively inexpensive and would enable MATS to carry airmen and some light cargo in support of SAC's nuclear-armed B–47s and B–52s, deployed worldwide. These immediately available commercial jets could also serve as stopgap aircraft until MATS's other new strategic airlift planes—the work-horse and the bulky-cargo carrier—arrived on the scene.[7]

General Tunner realized, however, that obtaining approval for the two costlier parts of his modernization plan, or even for one of the expensive new planes, faced odds so formidable as to be virtually impossible. Yet, MATS had nothing to lose in trying. Tunner therefore argued that deletion or omission of either transport would sooner or later compromise the airlift logistics system. As the MATS commander expected, his proposal, as a whole, did not have a chance and was turned down by the Air Force, but one part of his ambitious plan fared better than he had dared to hope.[8]

Unforeseen events contributed to Tunner's success. The Congo crisis of 1960, during which the former Belgian colony plunged into anarchy, demonstrated anew the importance of moving men and cargo quickly over extreme distances and underscored the existing deficiencies in strategic airlift. The Congo operation, nicknamed New Tape, ended in January 1964, after MATS C–124, C–133, and jet-powered C–135s had flown 63,798 passengers and 18,593 tons of cargo. Most of the New Tape missions originated in either the United States or West Germany, because of the difficulty in obtaining clearance for aircraft to fly over or take off from the soil of France.[9]

The Big Lift exercise in the summer of 1963 was designed to show how the Military Airlift Transport Service operating from bases in the United States might reinforce in record time the military commands of the North Atlantic Treaty Organization (NATO). During the exercise, MATS crews flew a hodgepodge of aircraft—C–54s, C–124s, some C–130s, and a few C–135s—dramatizing the need for a more homogenous airlift force. Big Lift succeeded, however, in flying an entire Army division overseas for the first time, and doing so in an impressive 63 hours and five minutes. The West German media did not fail to point out that in a true crisis the deployment might well have had a different outcome. West German reporters, with tongue in cheek, commented that American soldiers would be well served to learn Russian, for in a true crisis Soviet troops advancing from the east would be on hand to greet them.[10] Despite the German reaction, Tunner could not be sure that Big Lift would be enough to get the public at large, and Congress in particular, to support his modernization program. Maj. Gen. James Ferguson, Director of Requirements in the Office of the Deputy Chief of Staff for Development, could draw up the technical characteristics of the work-horse or the outsize cargo plane that Tunner sought, but if Congress did not cooperate there would be no money to buy either one.[11]

Another development outside of Tunner's purview, this one in 1960, helped shape the future of MATS. On March 4, Generals White and Lemnitzer signed an agreement which spelled out the numbers of Army units, troops, and tonnage of supplies that airlift forces would be expected to deploy to various parts of the world within given periods of time. The Chiefs of Staff of the Air Force and Army agreed that air transport ought to be able to deploy one division anywhere in the world within seven to ten days and two divisions anywhere within thirty days. However, officials of both military services admitted that, for the near future, the agreement could serve only as a long-term objective. Even though the Air Force received 47 percent of the defense budget, the service continued to stress the nuclear retaliatory mission, and Congress showed little interest in MATS. Once again, Tunner set out to capture the attention of Congress.[12]

Using all the influence he could muster, including the help of two Army generals—Lemnitzer and Bruce C. Clarke, Commander of the Continental Army

Command—Tunner organized Operation Big Slam/Puerto Pine, a joint exercise that airlifted some 21,000 Army troops and 11,000 tons of cargo from fourteen bases in the continental United States to Puerto Rico, an island less than a thousand miles from the mainland.[13] Begun on March 14, 1960, the two-week exercise came almost one month to the day after the MATS commander appeared before a special House subcommittee, organized by Rep. Carl Vinson, the Georgia Democrat serving as chairman of the House Armed Services Committee, and headed by Rep. L. Mendel Rivers, a Democrat from South Carolina. The subcommittee had sought to determine if the $120.4 million, included in the Defense budget request for fiscal year 1961 to modernize the airlift forces, was enough for that purpose.[14]

Tunner considered the sum totally inadequate. In his testimony, Tunner insisted that 454 MATS aircraft were "obsolescent in speed, range and overall capability," but, as subcommittee chairman Rivers observed afterward, "there was no sentiment whatsoever in the Defense Establishment for the support of interim modernization of MATS, and there was even open hostility in some quarters outside of the Defense Establishment." The MATS commander had anticipated the negative reaction described by Chairman Rivers. It was in this antagonistic climate that he organized Operation Big Slam/Puerto Pine.[15]

General Tunner's plans for Big Slam/Puerto Pine were characteristically thorough and the results impressive, considering the forces available. Statistics told the story: 1,250 round trips, with a total of 50,496 flying hours, with planes rolling into Puerto Rico like clockwork, unloading troops who moved smoothly to dispersal areas. Clearly, the Air Force and Army personnel proved themselves, but the MATS aircraft failed the test. The airmen worked to the limit of their endurance (twelve hours daily or more) with planes that were slow, short-range, and old. Because of the fleet's limited capability, only 10,000-to-11,000 tons of cargo could be airlifted, including one light tank, a few trucks (some with empty gas tanks to lighten the load), and artillery. Many troops landed without a single round of ammunition.[16]

As Tunner hoped, the joint exercise clearly served its purpose. Senators, representatives, and important civilian and military members of the Eisenhower administration came to Puerto Rico to see the airlift first hand, along with American and foreign reporters. More than 350 of these reporters were flooding the media with on-the-scene stories, and amid the deluge the most determined opponents of airlift modernization within the American press began changing their minds. Commentators no longer accused MATS of being a wasteful bureaucracy. Richard Fryklund, of the *Washington Star*, wrote that, from the standpoint of equipment, the major Army-Air Force strategic airlift seemed to have demonstrated its inadequacy, not because of inefficient leadership but because the Air Force planes were too few and too old, and much of the Army equipment could not fit in any of the available aircraft.[17]

The joint maneuver generated countless critiques, similar to that of the conservative *Washington Star*, one of the nation's most respected evening newspapers. Hanson W. Baldwin, military analyst of the more liberal *New York Times*, shared Richard Fryklund's point of view. Sen. Dennis Chavez, chairman of the Defense Subcommittee of the Senate Appropriations Committee, complained that MATS had to use outdated aircraft, some of which had already outlived their planned useful life. The senator warned that MATS did not have sufficient modern military aircraft "for the needs of the world in which we live today," adding that both Congress and the Executive branch "must take prompt actions in this area of national defense."

Tunner's appraisal of the exercise proved remarkably candid. If his command had so much trouble bringing equipment to an island this close to the United States, he observed, how would it cope with a far away conflict. Should there be a serious conflagration in the

Middle East or Asia, he predicted, "the initial airlift could put down only one or two companies, a force too small to hold a bridgehead. It would take at least a month to move in a full [Army] division with re-supply."[18]

After Operation Big Slam/Puerto Pine changed popular and Congressional opinions, events moved rapidly. On July 1, 1960, Congress appropriated an extra $200 million for the Air Force to buy or modify existing airlift aircraft, earmarking $50 million of the additional funds to begin the development of one of the two cargo planes proposed by Tunner and approved by General Ferguson less than a year before. On November 15, following several minor revisions, a final version of Specific Operational Requirement (SOR) 182 emerged, calling for a long-range jet designed principally to haul cargo. On December 21, requests for proposal were sent to Boeing, Douglas, Convair, and Lockheed, judged to be the most qualified competitors. For all practical purposes, the new strategic cargo aircraft that was to become one of the Air Force's favorite workhorses came into being during the last days of the Eisenhower administration. Of the four competitors, Lockheed had a clear advantage because of its experience in producing the C–130 tactical transport.[19]

On March 13, 1961, President Kennedy announced that the Lockheed Aircraft Corporation had won the competition, which in 1963 produced the C–141 Starlifter. The C–141 was designed for easy maintenance, efficient loading, and relatively short landing and takeoff. Powered by four Pratt and Whitney TF33–P–7 turbofan engines, the C–141, with an empty weight of 134,200 pounds, could to carry 70,000 pounds of cargo or 154 troops at more than 500 miles per hour. The transport could haul 63,000 pounds of cargo nearly 4,000 miles without refueling and exceed a range of 5,200 miles at reduced speed and payload. The first squadron of Starlifters entered service in the spring of 1965.[20]

In the meantime, General Taylor's proposed flexible response, first advocated in the early fifties, continued to gain momentum. The Air Force, committed to strategic deterrence, remained ill prepared to carry out this strategic concept and its attendant requirement for rapid airlift. In the field, the Tactical Air Command and the U.S. Strike Command (STRICOM), the latter a new unified command formed from combat units of TAC and the Army's Strategic Army Corps, soon found that the demand for tactical and strategic airlift far outstripped resources. Moreover, the Army's plans clearly indicated that still more airlift would be needed. For example, the Army intended to add about 3,500 troops to each airborne division and to double the tonnage of equipment and supplies. The Army also intended to triple the tonnage required to support a heavy infantry division, to increase the Strategic Army Command's number of divisions from two to a minimum of six, and to make these divisions as air-mobile as possible.[21] Understandably, the Air Force became increasingly concerned by the Army's aggressive planning.[22]

The Air Force's concern stemmed in part from the rapid growth of Army Aviation. By 1959, the Army air arm flew some 5,500 fixed-wing and rotary-wing aircraft, an increase of 4,800 since 1950, and had authorization to acquire 6,400. Since the Department of Defense had recently waived the earlier weight restrictions, the Army's future purchases would include a hundred twin-turboprop deHavilland short-take-off-and-landing transports that could carry a 10,000-pound load, like the C–47, the legendary Gooney Bird of War II.

Other events during the late fifties and early sixties also prodded the Air Force toward launching the costly C–5A program. In 1960, Deputy Secretary of Defense James H. Douglas, inspired by the increasing Congressional support for preparing to fight limited wars, recommended that future force structures deal with these conflicts. Although the Air Force emphatically rejected Secretary Douglas's suggestion, as did the Department of Defense, the institutional Air Force, and General LeMay in particular, believed that the victory might be

short lived. The Kennedy administration's acceptance of the concept of flexible response in early 1961 hardly alleviated LeMay's concern. In the spring of 1962, when Secretary of Defense McNamara directed a review of the Army's tactical mobility requirements, the Air Force became concerned that the Army planned to acquire another Air Corps of its own and, if Air Force airlift remained unsatisfactory, might attempt to take over the long-range movement of troops.

General LeMay, like other leaders before him, recognized that playing ball with one's opponent often proved the best way to frustrate a rival's ambitions. More important, even before the end of the 1950s, LeMay had become convinced that overseas crises were bound to arise and that the nation in future decades would unavoidably become involved in limited wars. Despite his realization that airlift would be necessary for limited conflicts, as pointed out by Tunner in early 1960, LeMay and the Air Force had to place an overriding priority on strategic nuclear forces, in effect relegating airlift to the status of a poor relative and postponing modernization of MATS for the foreseeable future.

The Vietnam War caused Army Aviation to expand substantially its mission, responsibilities, and capabilities. Individual field commanders retained operational control of the expanded assets even though the 1st Aviation Brigade had been activated in March 1966 to manage the logistics and training standards of Army Aviation units in Vietnam. These actions reflected Army doctrine and seemed to indicate that the Army was not truly thinking of reacquiring an air arm of its own.

In April 1966 Gen. John P. McConnell, the Air Force's new Chief of Staff, sought to clarify the status of Army aviation when he signed an agreement with the Army Chief of Staff, Gen. Harold K. Johnson, that allowed the Army to operate helicopters in the size and numbers and needed for battlefield mobility and supply. In exchange, the Air Force acquired the newly purchased deHavilland turboprops, known as CV—2s until they donned Air Force markings and became C–7s. The McConnell-Johnson agreement may have indicated that the Air Force of 1966, or at least its Chief of Staff, saw nothing to fear from Army aviation, or simply that it wanted nothing to do with Army helicopters. Whatever the motivation, the agreement did not square completely with Air Force doctrine that only an airman could control Air Force units, for the smaller tactical transports in Vietnam, the C–7s and C–123s, could be attached to Army commanders in time of emergency.[23]

In the meantime, the Air Force as early as 1961 had begun thinking about another new, multi-purpose, long-endurance transport to complement the C–141. In October of that year, the Military Air Transport Service received a qualitative operational requirement (QOR) from Air Force headquarters for a successor to the turboprop Douglas C–133, which could accommodate a strategic missile in its cargo bay but lacked reliability, as demonstrated by several unexplained crashes, and ease of maintenance. After careful review of the QOR, MATS officials concluded that the new transport should be available before mid-1967. Also according to MATS, some 160 of these new aircraft would be required to support a limited war contingency operation in a single theater, more in the event of a simultaneous emergency elsewhere. Air Force headquarters subsequently drafted a specific operational requirement designed to take care of the Army's known requirements. In August 1962, however, the proposed transport, by then referred to as program CX—4, crashed because, in the Army's opinion, it did not represent any "significant advance" over the C–141.[24]

The first jet transport designed primarily to haul cargo, the C–141, reflected the deployment concepts of the late 1950s. As briefly stated by Generals White and Lemnitzer in their initial agreement of 1960, the C–141 would also transport lightly equipped airborne troops. In addition, the new transport had to satisfy two specific objectives: McNamara's

demand for cost-effectiveness; and the Military Air Transport Service's insistence that its new jet be economical in peacetime airline-type operations.[25]

Although the C–141 offered impressive economies in cost per ton-mile (the cost of transporting a one ton of cargo one mile), it could not carry bulky items of Army cargo like bridges and tanks. McNamara, therefore, began to consider other options, such as a swing-tail version of the Boeing 707 passenger jet. Another option, also requiring extensive modification, involved extending fuselage of the C–141, which would increase take off and landing distance. Since the C–141 would serve alongside any new transport, Secretary McNamara decided to avoid investing the time needed to stretch the existing aircraft and bring it into the inventory as quickly as possible. By 1969 the airlift of nuclear weapons and total flying hours of the Military Air Command (MAC), as MATS had been redesignated, began declining sharply, a reduction attributed to the increasing use of jet aircraft, the C–141 in particular. (See Appendix 6).[26]

In 1961, when the success of the C–141 appeared by no means certain, the Army nevertheless wanted something more than the Starlifter—a transport capable of flying 4,000 nautical miles with a minimum payload of 135,000 pounds, a payload about twice that of the C–141. In addition, a 15-foot-wide fuselage would be necessary to take care of bulky Army equipment, and the transport would have to be capable of parachuting both cargo and troops. Finally, in view of the nation's commitments, the new aircraft would have to be able to use "less than ideal airfields."[27]

The Air Force did not argue the validity of the Army's requirements, but doubted that they could be satisfied without postponing the transport's planned initial operational capability (IOC) beyond 1967, the objective listed in the recent QOR. To begin with, new, larger turbofan engines would have to be developed. Moreover, so large an aircraft would probably require other significant technological advances that would cause further delay. Despite its misgivings, the Air Force on June 20, 1963, released another version of the CX—4 SOR, which by and large promised the Army what it wanted. Most important, the revised CX—4 would be designed to operate from what the Air Force described as "rear or support-area fields," which might or might not prove synonymous with the Army's "less than ideal airfields." The aircraft, moreover, would be reliable and have "maximum self-sufficiency," which meant that it would need "little or no prepositioned equipment" to remain operational. This SOR, however, proved no more realistic than the initial one, and the CX–4 did not materialize. The Army had nothing to do with this failure, which resulted from developments at the highest levels of the Air Force.

The Imprint of Project Forecast

April 1963 saw the emergence of Forecast, a project suggested by Secretary of the Air Force Eugene Zuckert, a former member of the faculty at the Harvard School of Business and from 1947 to 1952 an assistant secretary to Secretaries of the Air Force Stuart Symington and Thomas K. Finletter. Gen. Curtis E. LeMay, Air Force Chief of Staff since June 30, 1961, enthusiastically supported Forecast, dedicated to the study of weapon systems for both the near term and the distant future. Gen. Bernard A. Schriever, since April 1961 in charge of the Air Force Systems Command, directed the project, which included analysis of Air Force logistics support and the Army's requirements for airlift, two topics that were tightly interwoven. Without hesitation, Forecast recommended development of a heavy logistics transport aircraft even more advanced than the plane suggested by the Army and only reluctantly endorsed by the Air Force in the revised SOR for the CX–4. Clearly, the airlift

recommendations approved by General Schriever proved more ambitious than Air Force headquarters had anticipated. However startling the Forecast proposals may have seemed at first, Schriever presented them forcefully and demonstrated that they made sense and were potentially worthwhile. Yet, converting the airlift recommendations into a new transport encountered unforeseen problems that took time to solve.[28]

Initiated by Project Forecast, the CX–Heavy Logistics Systems (CX–HLS) replaced the proposed CX–4 and produced the Lockheed-Georgia C–5A, which flew under stringent restrictions until February 2, 1983 and did not achieve its full potential 1986 and the advent of the C–5B. Schriever hoped for a time to develop an even heavier transport, weighing a million pounds compared to 840,000 pounds for the C–5A and C–5B, but abandoned the more ambitious undertaking, probably because Secretary of Defense McNamara insisted that any new transport achieve an initial operational capability in 1969 or be canceled.

Project Forecast, eventually endorsed by McNamara, did not attempt to define the configuration of the new CX–HLS but pointed out that equipping it with only four engines, instead of six as planned for the defunct CX–4, might bring significant savings. Based on a 200-aircraft program, a four-engine transport would eliminate the purchase of 400 engines, perhaps twice that many if including the usual spares. In October 1963, General Schriever instructed the Deputy for Advanced Systems Planning of the AFSC's Aeronautical Systems Division (ASD) to work on a detailed design concept and technology study of the new transport, now known as the CX–X.[29]

By the end of October 1963, guidelines for the CX–X conceptual design had been devised, and many studies were in progress. As now envisioned, the CX–X would have a gross weight of 550,000 pounds, a maximum payload of 180,000 pounds, a maximum speed of Mach .75; and an unrefueled range of 5,000 nautical miles with a payload of 115,000 pounds. The cargo compartment would be large—measuring 17 1/5 feet wide by 13 1/2 feet high and 100 feet long—with access through doors at the front and rear. At the designed takeoff gross weight, the distance to become airborne would not exceed 6,000 feet. These requirements, current studies revealed, could be nearly met with existing technology or completely fulfilled, or even exceeded, depending on new approaches. Whereas today's technology and off-the-shelf engines would produce disappointing performance, new engines and the use of lightweight composite materials in the airframe would yield better results but require a greater investment of time. Achieving the best results would require even more time and innovation, making use of new materials and engines and also incorporating laminar-flow control, which consisted of a series of holes in the wing to divert the flow of air and make sure the razor-thin layer of air closest to the wing, the boundary layer, did not separate from the upper surface of the airfoil and impede lift. When functioning as designed, such a device reduced drag and, in theory at least, could extend by forty percent the range of a 400,000-pound airplane.

On November 20, 1963, AFSC put together a draft Advanced Development Objective (ADO) for the CX–X long-range logistics transport. Although general in nature, this prospectus emphasized that performance objectives would have to be met. To do so would require capitalizing on technical developments, particularly in such areas as high-bypass turbofan engines, laminar flow control, a readily accessible cargo compartment, and a high-flotation landing gear to spread the massive weight of the fully loaded airplane. The ADO specified that the CX–X had to be able to carry a 100,000-pound payload 10,000 nautical miles without refueling, and 180,000 pounds at lesser ranges. The CX–X cargo compartment had to be compatible with the standard cargo handling system and provide rear-door loading. Finally, the document projected a first flight in mid-1969, an initial operational capability in

late 1971, and a two-year production program, followed by long and useful service.[30]

On November 29, 1963, only six days after dissemination of the ADO, General Schriever directed Maj. Gen. Robert G. Ruegg, Commander of the Aeronautical Systems Division, to assume responsibility for CX–X development. Besides establishing a project office to manage the initial activities, ASD would at once prepare a preliminary program schedule and a request for proposal (RFP) to notify prospective contractors of what was wanted and explain how their proposals would be evaluated. The RFP would also identify the probable terms and conditions of the subsequent contracts for development and procurement. Schriever informed Maj. Gen. Marvin C. Demler, Commander of AFSC's Research and Technology Division, that engine proposals were likewise needed, since the new engines were the most critical of the many elements of the CX–X requiring advanced technology. Demler knew engines well, having served as an expert in propulsion for General Arnold during World War II before becoming involved Silver Plate, the project to modify B–29s to deliver the atomic bomb. The assignment of tasks to capable officers like Ruegg and Demler was easy, but getting the institutional Air Force to endorse the CX–X Advanced Development Objective proved an intricate process.[31]

Lt. Gen. Joe W. Kelly, Commander of the Military Air Transport Service which would operate the new transport, found the CX–X ADO far too ambitious. MATS had not requested so advanced a transport in its SOR, and, though Kelly recognized that Schriever's mandate was to advance technology, he pointed out that his own obligation was to obtain for MATS the most reliable airplane possible. From Kelly's viewpoint, the characteristics of the CX–4, revised and then abandoned, had been well defined. Only "minor technical problems" remained with the CX–4, and these could be solved with "current state-of-the art technology," enabling MATS to meet the requirement, now being emphasized, that a new transport attain an early initial operational capability.

Intent upon advancing the limits of technology at Systems Command, Schriever could not have disagreed more. He believed that the revised specific operational requirement for the CX–4 envisaged an interim aircraft only, and an inadequate one at that. What MATS needed, in the AFSC Commander's adamant opinion, was the best CX–X, and technological advances proposed for such an aircraft could not be sacrificed for the sake of expediency. This seemed especially important because the future new transport was due to stay in the operational inventory for several decades.

Gen. Mark E. Bradley, Jr., Commander of the Air Force Logistics Command, agreed with Schriever up to a point. His own reservations centered on the proposed 10,000-nautical-mile unrefueled range with a 100,000-pound payload. General Bradley also criticized the CX–X cargo compartment which, regardless of its large size, could not accommodate the 200,000-pound solid-fuel rocket motors being developed by National Aeronautics and Space Administration. When it came to the aircraft's IOC, the AFLC and MATS Commanders disagreed entirely. General Bradley saw no urgency, claiming that "existing [transport] aircraft should meet basic mission needs until 1971 which should give ample time to introduce an optimum cargo carrier that would fulfill Air Force mission requirements until 1990."

Requests for Proposal for the Heavy Logistics System (CX–HLS), as the CX–X was now known, went to prospective airframe and propulsion contractors on April 27, 1964. As routinely done, the RFPs came on the heels of a Specific Operational Requirement (SOR) that had been put together in March. SOR 214, as the document was labeled, initially rehashed the Advanced Development Objective of December 1963 but underwent revision during the following year. Hence, on May 5, 1964, the Air Force convened a briefing for the likely

bidders to explain better what the government had in mind, and to emphasize the project's urgency, a factor, the Air Force knew, that was becoming increasingly crucial.[32]

On May 18, 1964, airframe proposals arrived from the Boeing Company, Douglas Aircraft Company, General Dynamics Corporation, Lockheed-Georgia Company, and Martin Marietta Corporation; the General Electric Company, Curtiss-Wright Corporation, and the Pratt and Whitney Aircraft Division of United Aircraft Corporation submitted engine proposals. On June 5, after rejecting the initial airframe proposals from General Dynamics and Martin-Marietta, the Air Force negotiated contracts with the three remaining competitors for parametric statistical studies of the airframe and with General Electric and Pratt and Whitney for parametric studies of an engine. Such studies had been authorized by the Department of Defense in December 1963, with some $17 million earmarked for this purpose, as well as for development of experimental hardware. Despite demanding completion of the studies by October 1964, a short deadline, the Air Force would, in retrospect, insist that no other aircraft had ever undergone so thorough an analysis.[33]

While these predevelopment procedures, typical of any major weapon system, unfolded, the question of an early IOC for the CX–HLS became increasingly important. In 1963, General Schriever, like General Bradley, had suggested the end of 1971 as a reasonable target, but in Washington the Air Staff insisted that the aircraft should become operational two years earlier. In effect, Air Force headquarters was following the lead of Secretary of Defense Robert S. McNamara, the champion of cost-effectiveness, who insisted that the service get the most for the money in developing, buying, and flying its airplanes. The C–124s and C–133s that MATS used to carry outsized cargoes were proving excessively expensive to fly; to promote cost-effectiveness they had to be replaced. The Air Force had two alternatives, either procure the CX–HLS or purchase more C–141s. If the new aircraft could not be available by the end of 1969, McNamara warned, additional C–141s would have to be bought and modified to meet projected deficits in airlift, "and the basic justification for the CX–HLS program would be eliminated." As far as the Secretary of Defense was concerned, every major weapon system had to appear in a timely fashion and fit into overall defense priorities and the objectives of the service acquiring it. In short, the urgent need for the new aircraft, heretofore a MATS requirement questioned by many Air Force leaders, had now become essential and beyond argument.[34]

In May 1964, Secretary McNamara authorized a larger C–141 fleet composed of 391 aircraft, of which 284 were funded and built. Since McNamara actually favored acquisition of the CX–HLS, he made it clear that the purchase of additional C–141s could be rescinded or adjusted downward and that any final decision would await the outcome in September of ongoing Air Force and industry studies. At the same time, the Secretary continued to insist that the aircraft achieve its IOC in 1969, thereby putting more pressure on the AFSC Commander.[35]

Convinced that the CX–HLS would be a lost cause unless the Air Force was prepared to meet Secretary McNamara's deadline, General Schriever looked for ways to speed the acquisition process. For example, could the engine development schedule be accelerated? General Demler agreed, after a "preliminary quick look," that development of a new engine could possibly be accelerated by one year if "an additional thirteen million [dollars] is provided in fiscal year 1965 and an expected decrease of 5 percent in propulsion performance is acceptable," keeping in mind, however, that few things are more hazardous than combining a new airplane with a new engine. Although the cost increase and loss of thrust predicted by Demler seemed bad enough, worse news soon followed.[36]

Despite positive progress reports on the ongoing parametric studies, Maj. Gen. Charles

H. Terhune, who in mid-July had replaced Maj. Gen. Ruegg as ASD Commander, was even more pessimistic than Demler. When queried by General Schriever, Terhune stated flatly that a 1969 IOC was so unrealistic as to be virtually unattainable, even under the very best of circumstances. To meet the goal, he added, would require accelerating not only the development and acquisition of the engine but the entire program definition phase, flight testing, and the aircraft production rate. Without doubt, this would cause serious consequences. Engines not yet fully tested would have to power the flight-test aircraft and also the first production models. The end result, Terhune warned, might well be a new transport incapable of satisfying the MATS requirements for reliability and utilization.[37]

The Total-Package Procurement Concept

General Terhune had more to say. He called attention to another factor he considered worrisome—the procurement concept conceived by Robert H. Charles, Assistant Secretary of the Air Force for Installations and Logistics, and apparently endorsed by Secretary McNamara. The total-package procurement concept (TPPC), as the new acquisition procedure was called, envisioned that development, production, and support requirements for a system would be bought under a single overarching contract. Moreover, price and performance commitments would be finalized during the contract's definition phase. The procurement technique advanced by Assistant Secretary Charles's procurement concept did not at first sight did not seem excessively radical. Commercial airplanes were often bought in advance of development, or before they were built or designed in detail. In such cases, commitments were made to a fixed price on the basis of cost experience, and the contractor could not change price or performance once a sale was consummated.[38]

Charles, who came to the Pentagon from the McDonnell aircraft company where he had served as an executive, declared that the practice worked well for the civilian airlines and should do so for the Air Force. His reasoning was flawed, however; indeed, he should have known better, and perhaps did. In commercial airline equipment, the manufacturer leads the way. In the commercial market, the manufacturer was the seller and "the seller sells to the customer who may or may not feel ready for a new airplane." In the case of a military airplane, however, it was the customer (in this case the Air Force) who established requirements for the manufacturer. The difference can be reduced to that between ready-made clothing, analogous to commercial airliners, and the tailor-made variety. Military equipment, including airframes and other components, are tailor-made; when the military customer decides he wants many more pockets in his suit instead of the usual number, he gets them—the cost simply goes up.

To demonstrate the applicability of commercial buying techniques to military procurement, Charles cited Pan American's purchase of the 707 from Boeing, which functioned as the sole contractor and was responsible for the 707's Pratt and Whitney engines. Pratt and Whitney did not answer to Pan Am but to Boeing, an early use of the basic principles of the TPPC. The case of the CX–HLS (soon to become the Lockheed-Georgia C–5A) would prove far more complex, however, for the winning prime contractor had to incorporate new engines in one of several configurations under consideration. The Air Force, therefore, decided to oversee development of the engines and, once they were working well, to give them to the airframe contractor, whoever it would be, as government furnished equipment. Then and only then, would the airframe contractor assume responsibility for the engines—a decision agreed upon by the competing airframe contractors, which, the winner, Lockheed, subsequently attempted to change.[39]

Just the same, most of the Air Force officials concerned with the acquisition of weapon systems shared General Terhune's misgivings. They acknowledged that procurement procedures could be improved but believed that the total-package procurement concept should be tried out only on a program much smaller and less ambitious than the CX–HLS. In addition, as Terhune repeatedly emphasized, the impact of the new procurement concept was unforeseeable because "the full implications are not completely understood at the outset."[40]

General Schriever, a long-standing advocate of decentralizing weapon system management and shifting it away from the Pentagon, anticipated Terhune's objections. The AFSC Commander was the first to deplore the management reforms endorsed by Secretary McNamara, for Schriever believed that the McNamara approach emphasized cost-effectiveness and centralization, curtailing Systems Command's hard-won autonomy and gradually eroding the importance of AFSC's system project offices.

Despite Schriever's protests, total-package procurement went ahead. On August 24, 1964, Assistant Secretary Charles and Dr. Alexander H. Flax, Assistant Secretary of the Air Force for Research and Development, conferred with the Air Staff on the status of the CX–HLS. Results of the parametric studies were still pending, but preliminary reports on engine development had provided important data. To gain time, General Electric and Pratt and Whitney had been awarded the previous week contracts totaling $10.7 million for operating, through December 1964, scale models of their engines fitted with improved components. Less encouraging to the uniformed leadership of the Air Force was the news that Charles and Flax had come away from the session with the impression that the ASD conferees doubted that a 1969 IOC could be achieved. On September 2, Headquarters AFSC directed its Aeronautical Systems Division to show a more positive attitude, insisting that it was "mandatory that the commander's direction be adhered to, i.e., `lean forward' and exude confidence in meeting 1969 date when giving CX–HLS briefing in the Pentagon."[41]

Results of the parametric studies, initiated in June, became available on September 15, 1964, and yielded a wealth of technical data for evaluating alternate design proposals relative to performance, costs, availability, and effectiveness. The firms competing to build the engine defined the characteristics and technology for the propulsion system. The three airframe contractors—Boeing, Douglas, and Lockheed—submitted designs based on gross weights of 500,000, 650,000, and 750,000 pounds, though the last was ruled out almost immediately. Besides gross weight, the variables included lift-to-drag ratio, number and types of engines, cruise speed and altitude, and maximum payload.

The studies also indicated that long-range missions and operational economy required a new engine design with better fuel consumption and thrust-to-weight ratio than available with off-the-shelf types. Drive-through loading of the aircraft, fore and aft, offered operational advantages at a minimum investment of weight and cost. From the standpoint of efficiency and cost effectiveness, the cargo compartment should provide 2,400 square feet of floor space. Finally, a high flotation landing gear would allow the aircraft to use poorly surfaced airfields.[42]

The results of the parametric studies reflected Project Forecast's most ambitious plans for a new subsonic transport; the giant aircraft would be revolutionary, not necessarily from the technical standpoint, but because of its major impact on the movement of combat forces. In any case, many conclusions of the studies had been known informally for quite some time, prompting enthusiastic meetings between members of the Forecast staff with the Air Staff and, especially, with representatives from the Deputy Chief of Staff (DCS) for Research and Development (R&D), an office headed by Lt. Gen. James Ferguson. Amid the enthusiasm, however, words of caution were heard. In late September 1964, for example, Dr. Flax was

still arguing with Maj. Gen. R. D. Curtin, Director, Development Plans, DCS/R&D, about the validity of comparing the development timetable of the CX–HLS with those of the C–141 and Douglas DC–8, since the latter two aircraft featured only minor departures in design from commercial aircraft previously built, using modifications of engines already in operation. On the other hand, the CX–HLS development schedule seemed far too compressed if based on radically new engines, such as General Electric's GE-1/6 turbofan. Dr. Flax also questioned the importance of the 6,000 pounds that a high-flotation gear would add to the aircraft weight, and the "small" investment and operating costs required for such an addition, since no figures were available and "smallness is a matter of degree or opinion."[43]

Undoubtedly, a great deal of urgent work remained to be done. In October 1964, in accordance with the usual practice, the Air Force began estimating the initial cost of the CX–HLS program, and the service appointed a source selection board on November 16. Delays occurred, however. For example, the Air Force did not complete new requests for proposal for both airframe and engine until December. Meanwhile, a revised CX–HLS report was being prepared for General Schriever's signature. The report, in its final form, listed potential alternatives and tradeoffs, endorsing as "mandatory" two items that MATS desired—the use of a new engine and straight-through loading, the latter including a kneeling landing gear that lowered the floor of the cargo compartment to truck-bed height—but merely recommending incorporation of a high flotation landing gear to give the airplane the capability for operating from support area airfields, which the using command also wanted, though ultimately did not need, since the C–5A would operate from runways of reinforced concrete. General Schriever sent the thorough and persuasive document to General Ferguson on October 20. Within two months, the hard-fought CX–HLS project would get under way.[44]

On November 21, 1964, Eugene Zuckert, in his capacity as Secretary of the Air Force, presented the case for the CX–HLS program to the Secretary of Defense informing him that the aircraft would be somewhat larger and therefore slightly heavier than previously expected. The larger aircraft, Secretary Zuckert asserted, would be more cost-effective since it would take fewer planes to carry out any given airlift mission. Furthermore, the scaled-up airframe design did not represent a "large advance in the current state-of-the-art, and the technological building blocks are in hand." Zuckert also expressed his confidence that a satisfactory engine would be available in time to achieve an initial operational capability in 1969.[45]

On December 4, 1964, the Secretary of Defense authorized development and procurement of three squadrons of heavy logistics aircraft—58 planes, test aircraft included. This was only half the minimum the Air Force asked for, but McNamara did not rule out an additional procurement. He also approved issuance of the requests for proposal, redesignated the CX–HLS as the C–5A, and again insisted on a mid-1969 IOC. Although McNamara's procurement decision required formal approval by the President, favorable action seemed certain enough to allow the Air Force to proceed. President Johnson endorsed McNamara's decision on December 22, 1964.[46]

The C–5A system project office, redesignated from CX–HLS office on December 10, 1964, issued a new request for proposal on the next day. This document, like its predecessor, embodied the specific operational requirement of March 1964 (SOR 214), the amendments adopted in May, plus the pending revisions to the SOR that were to become official on January 5, 1965. The salient points of such revisions were the so-called October specifications, identified in Schriever's report, sent to General Ferguson, and subsequently approved by McNamara.[47]

To save time and money, the new request for proposal was only sent to the parametric and engineering study contractors (Boeing, Douglas, and Lockheed for the airframe, General Electric and Pratt and Whitney for the engine), since they obviously were the most qualified. In other words, source selection competition ended, and the definition contracts went to the manufacturers who had participated in the parametric study program. Despite the shortcut, the new RFP lagged forty days behind the tight schedule outlined by the Aeronautical Systems Division to make the C–5A operational before 1970. Terhune, the recently appointed ASD Commander, did not hide his indignation from Schriever. The initial delay, the inevitable doubling of effort that would ensue if more reasonable deadlines were not established, and the lack of an orderly course of action during the program definition phase, Terhune declared, would "jeopardize our chances of success in defining a system which does not require numerous changes after contract award." The ASD Commander also pointed out that these changes down the line would not only undermine the effectiveness of the total-package procurement concept, but also have an adverse effect upon meeting an IOC in mid-1969 as required. General Terhune's protest proved ineffectual, though grounded in fact. The RFP transmittal letters, and the many provisions of the total-package procurement document approved in February 1965, indicated trouble to come.[48]

Since a new acquisition procedure was being used to procure the C–5A, the letters accompanying the requests for proposal of December 11, 1964, had to be somewhat unusual. They explained what the Air Force wanted, told how it intended to proceed, and generally clarified most aspects of the total-package procurement concept. Certainly, the most pressing requirements were clearly defined. Specifically, contract awards would follow the completion of several phases. The first phase would be Concept Formulation, based on the results of the earlier parametric studies. Contract Definition would come next, when the contractors would receive fixed price contracts to write package proposals based on their concept formulation inputs. In addition to defining its preliminary system design, every package proposal had to detail the competitor's development activities, facilities design, plans, tests, production schedules, logistics support, and cost.[49]

The Air Force also informed the companies that contractors, still qualified after completion of the phases through contract definition, would have to sign the very same TPPC acquisition contract which, in due time, would be awarded to the final winners of the airframe and engine competition. Qualified contractors already realized the project's potential magnitude, but the Air Force again emphasized that the C–5A program, although restricted to a relatively small initial purchase, could eventually total as many as 200 aircraft. The approved purchase of 58 C–5As, known as Production Run A, would almost surely be followed by the procurement of another 57 C–5As, referred to as Production Run B. Finally, a last buy of 85 aircraft, or Production Run C, was anticipated, and other purchases by commercial cargo carriers might also materialize. Engine procurement followed the same pattern, though the numbers differed; Run A covered 290 engines, Run B 285, and Run C 425, for a possible grand total of 1,000. The figures underwent change when the engine contract was signed, but the differences proved minimal.[50]

Not surprisingly, in view of the considerable financial value of the pending production contracts, competition was fierce, and all contractor proposals arrived on December 21, 1964. Despite the prompt responses, Secretary McNamara delayed his approval of the total-package arrangement until February 25, 1965, even though Charles, the Assistant Secretary of the Air Force for Installations and Logistics, had been presenting convincing arguments for months in support of the new technique. In the words of Assistant Secretary Charles, "the history of defense procurement was replete with staggering cost overruns and disappointing

technical performances," fiascos for which he offered no excuses. One possibly valid explanation lurked in the background, however. The technological advances of the immediate post-World War II period might have resulted in projects requiring extensive research and development that unavoidably produced increasingly complex and costly weapons. Later, the growing Soviet threat and the need to retain supremacy shifted the emphasis from competition among contractors and economy to numbers and performance, even though competition remained enshrined in procurement regulations and, in theory, still favored the "lowest responsible bidder."[51]

Charles did not deny that traditional procurement approach could work well. Indeed, most development contracts were negotiated in a highly competitive atmosphere, with emphasis on technical excellence at the lowest possible cost. After a competitor won a development contract, however, which as a rule barely represented 20 percent of the projected work, the firm's financial problems were practically over. As Charles pointed out, "contractors could afford to submit underpriced development estimates and exaggerated claims of technical performances," since the government, once committed to the winner, had no easy escape, and the contractor was assured of reaping significant profits during the ensuing production run, which typically accounted for more than 80 percent of the total work.[52]

In these circumstances, the Air Force could ill afford the delays and extra costs that would accrue in choosing a different contractor to build the airplane. By the same token, if the experimental hardware did not satisfy the Air Force requirements, cancellation of the production contracts would waste the money invested in development and postpone further the introduction of a satisfactory version of the weapon into the Air Force inventory. Hence, the initial production contract, follow-on production contracts, and contracts for spares, aerospace equipment, and the like, were negotiated with the winner of the development contract without any competitive bargaining. Of course, even under the old procedures, the Air Force did its best to protect itself, and production contracts featured all sorts of built-in provisions to keep the contractors in line. Sometimes, the arrangements worked very well, the Strategic Air Command's B–52, manufactured by the Boeing Airplane Company, being a case in point. Occasionally, cost overruns went wild, as borne out by the B–58, another bomber produced for the same command by the Convair Division of the General Dynamics Corporation.[53]

Against this background, and since development and production of the C–5A was not expected to involve large steps beyond the technical expertise of the aircraft industry, Secretary Charles's total-package procurement appeared highly attractive, at least in theory. Moreover, it certainly met McNamara's requirement for cost-effectiveness, even though one aspect of the new approach, promoting flexible-cost incentive formulas, was immediately ruled out for two reasons. First, it conceivably could induce the contractor to reduce his cost estimates at the outset in order to win the competition and ensure his future profit. Second, it would be unlikely to reduce the cost to the government. Instead, as spelled out in the transmittal letters of December 11, 1964, the companies had to submit cost proposals with only fixed-price, incentive-sharing arrangements.

The letters of transmittal also explained that, because of the total-package procurement concept, selection of a winner would not be based solely on the merits of an aircraft design but on the "overall cost effectiveness over a ten-year operational period of a system which complies with the Air Force stated requirements." Thus, production and support, as well as development, were to be determining factors. Since competitors had to submit cost estimates, or target prices, for a quantity of aircraft exceeding that to be initially purchased, and production and support costs were estimated for several years in the future,

the contract contained a clause to protect the airframe and engine winners against "abnormal" economic fluctuations until January 1968—a date some three years away, beyond which the government could not estimate potential rates of inflation. From 1968 on, target and ceiling prices would be subject to annual revisions, based on contractor costs, including labor, material, equipment, and any additional subcontractor expenses. In essence, the protection aided the airframe contractor, since he would be responsible for the total operation of the aircraft system, including, after delivery of the engines, the correction of any deficiencies affecting performance.

Other provisions, however, seemed unlikely to please the manufacturers. For example, contractor proposals were to specify the "highest" standards they expected to reach; such standards would then become the Air Force's "minimum acceptable contract standards." Since contractors traditionally outdid each other with exaggerated claims of performance, the new provision came as an unpleasant surprise. Correction of deficiencies, also was an integral part of the new procurement technique and it would be enforced from the start. Strict enforcement seemed necessary because the Air Force, in order to save time, arranged for production to begin before flight testing ended. If the tests revealed that the aircraft did not meet all the specifications in the contract, the manufacturer would be compelled to make the necessary corrections at his own expense. Finally, another important but unrelated clause pertained to contract changes amounting to $100,000 or less, which would have to be made as requested by the Air Force with no change in target cost, profit, or ceiling price.[54]

The C–5A Program Approved

On January 8, 1965, after a briefing on the many intricacies of total-package procurement, Secretary McNamara gave his final approval, though not without qualifications. These did not mean that the Secretary had lost his enthusiasm for the C–5A. On the contrary, as a tool for carrying out the concept of flexible response, the C–5A program, at least in the beginning, proved to be one of the rare occurrences during McNamara's tenure as Secretary of Defense, when he and the unformed military leaders appeared to be in complete agreement—an irony, considering the many problems that were to plague the aircraft and the many difficulties attributed to the new procurement technique. Although McNamara came from the world of heavy industry—the Ford Motor Company—he had been a highly successful statistician for the Army Air Forces during World War II and brought to the Department of Defense the financial and statistical orientation, and a caution, usually associated with banking rather than manufacturing.[55]

Caution compelled McNamara to request that the plan undergo thorough review by the Director of Defense Research and Engineering, the Assistant Secretary of Defense (Comptroller), the Assistant Secretary of Defense for Installations and Logistics, and the General Counsel. In addition, Congress would receive detailed information about the new procurement technique. Given his interest in statistics and finance, McNamara insisted that the C–5A enter service on time and at a reasonable cost. He directed that "the ground rules and basis for computing total system cost effectiveness ... be clarified and explicitly defined for all competitors as soon as possible, in order to avoid possible inconsistencies in interpretation," which could carry the risk of delay in the start of development and slippage of the C–5A's operational date. The risk of delay was very real, the Secretary of Defense noted, and would have the greatest impact on "the time span allowed for government evaluation of the contractor proposals," selection of the winners, and execution of contracts with subject contractors.[56]

As recommended by Harold Brown, the Director of Defense Research and Engineering, McNamara entrusted Secretary of the Air Force Zuckert to oversee the project and gave him principal authority to decide the winners of the competition. This confidence in Zuckert may have stemmed from his support of McNamara during the TFX [Tactical Fighter experimental] controversy, when the Secretary of Defense tried unsuccessfully to compel the Navy and Air Force to accept slightly different versions of the F–111 fighter. Although McNamara fully endorsed the total-package procurement concept conceived by Charles, he proceeded with circumspection, delayed his approval of the contract until February 1965, and seemed less than certain that the new procurement concept would be totally successful.[57]

Since the Air Force believed, correctly, that McNamara would approve total-package procurement, the service did not slacken its efforts to speed the development process, since any delay might prompt the Secretary of Defense to cancel the program. Hence, on December 31, 1964, only ten days after receipt of the competing proposals, so-called project or program definition contracts were issued to Boeing, Douglas, and Lockheed for the airframe, and to General Electric and Pratt and Whitney for the engine. In short, production of the C–5A seemed a foregone conclusion. Dr. Brown had recently told Dr. Flax that, should the new procurement technique prove unworkable, the government could fall back on the conventional procedure of a development contract, followed by a production one. To avoid weakening the government's negotiating position, contractors had to be kept totally unaware of this alternative; officially, the definition contracts would have to remain the sole basis for the production decision. Moreover, since the total-package procurement seemed the order of the day as far as Secretary McNamara was concerned, the C–5A system project office had to keep on clarifying for the contractors the intricacies of the new procurement technique.[58]

According to General Terhune, educating the contractors had been a difficult undertaking from the start. Initially, the undermanned system project office received insufficient guidance from the Air Force Systems Command, and other Air Force commands and agencies failed to assign persons to the office from the outset. Because competitiveness formed an essential part of the total-package procurement, engineers of the Aeronautical Systems Division had to be careful not to reveal inadvertently to a competitor design information received from another contractor. Nor could the Air Force engineers offer advice about design proposals. Understandably, contractors were equally cautious when it came to revealing information to a rival; they flooded the program office with written requests for clarification but remained practically mute during the several explanatory briefings held by program representatives.

In mid-January 1965, still concerned by the short time allocated for system definition, program officials asked about the impact on schedules and costs if the definition period should be extended, but the trial balloon was immediately punctured. Douglas did not want additional time without an extra payment of $2 million to cover its additional costs, including retention of its work force should it become idle because of the extension. Lockheed, behind schedule as a result of resizing its aircraft, wanted an extension but did not mention money. However, if the government should provide extensions and additional funds to other contractors, Lockheed would certainly expect to receive the same financial compensation. Boeing, believing it led in the competition, opposed an extension which could only benefit its competitors, but if ASD insisted on an extension, Boeing also would want $2 million in compensation. Reactions of the engine contractors proved similar; only the amounts differed. Meanwhile, as of December 31, 1964, the airframe contractors had been paid $7.1 million apiece for their endeavors, while each of the two engine contractors had received about $2 million. Yet, except for General Electric and Pratt and Whitney, the work apparently was

becoming far more costly than expected. Years later, an Air Force reviewing team reported that, regardless of what the contractors had been paid, the entire competition had probably cost each airframe competitor some $50 million.[59]

Another important facet of the total-package procurement concept was program funding. Whereas Dr. Brown had endorsed a request from the C–5A program office request to deviate from the procurement funding procedures in place since the spring of 1957, Secretary McNamara stated on February 25, 1965, that the C–5A production would not receive special funding privileges. In other words, whoever won the C–5A contract would be unable to reduce production costs by ordering ahead of time large quantities of material from the various suppliers. The winning contractor would also be handicapped in dealing with subcontractors since money would be provided only in fiscal-year increments, "as in the case of any other major weapon system for the quantity programmed for the applicable program year." In addition, contract terms limited governmental liability should the program be terminated or reduced, and the contractor could not, of its own volition, accelerate the pace of production. However, to ease the contractor's financial burden during the system development, testing, and production implementation, McNamara permitted progress payments for work actually completed to be increased to 90 percent from the usual 70 percent.[60]

The Study of March 1965: Weight and Engines

As Zuckert requested in mid-1964, the Air Force in March 1965 completed a cost study of the C–5A program that included design, development, testing, evaluation, investment, and operations through fiscal 1974. Studies like this one, done by the Aeronautical Systems Division of the AFSC, were not unusual. The Air Force as a rule attempted to estimate the future cost of a new weapon system using the cost data of related systems. In the case of the C–5, the costs of the C–130, C–135, and C–141 provided the basis for comparison. Yet, as the Air Force and Department of Defense knew, comparing costs in this fashion could be a risky business. For example, the C–141 featured engines already developed and in use throughout the aircraft industry. In contrast, no one knew for a time how many engines would equip the C–5, or what kind of engines the Air Force and the winning engine contractor would provide. Although the C–5 was expected to be well within the state of the art, its enormous weight would require special engines with very powerful thrust, and an engine, after all, is an airplane's most critical component. Total cost for 115 aircraft (refurbished test aircraft, included) was estimated to approach $3.7 billion. The March 1965 study was intended to serve as a standard to determine during the aircraft acquisition process if the proposals from the contractors were reasonable. Cost estimates had already been computed on several occasions and their importance explained to the contractors. Yet, the March document was the first study encompassing not only the complexity of project engineering, but also a providing a "paper weight model," an estimate of the weight of the future C–5A, a necessary precaution in view of recent weight increases. Unfortunately, the Air Force cost study and "paper weight model" of March 1965 proved futile gestures, when cost and structural difficulties, the latter undoubtedly due to saving weight, beset the C–5A in later years.

As a basis for calculating the cost of the competing airframes, the Aeronautical Systems Division used the Lockheed C–130, the Boeing KC–135, the Douglas C–133, and another Lockheed transport, the C–141. Engine cost data came from the Pratt and Whitney TF30 of the General Dynamics F–111, from the General Electric axial turbojet J93 of the

experimental North American B–70, and from the Pratt and Whitney TF33 of the C–141; the KC–135 and C–141 provided data for avionics, ground paraphernalia, and training equipment. Since transport and cargo planes did not need the same kinds of sophisticated and often interconnected components as bombers and fighters, their operational requirements as a rule were reasonably straightforward, and contractors had fewer opportunities to pad their proposals with enticing claims of technical performance. For one reason or another, however, cost overruns still occurred in transport and cargo craft.

Consequently, if most of the past failings of aircraft procurement identified by Assistant Secretary Charles were valid, they cast doubts on the accuracy of the several billion dollars in cost estimates calculated over the years by the Aeronautical Systems Division. Moreover, predicting a program's total cost over a period of nearly ten years seemed an overly ambitious and risky undertaking. Despite the doubts about its past work, by March 1965, the Aeronautical Systems Division had reached a conclusion regarding the C–5. For 115 aircraft (Production Runs A and B), ASD cost analysts came up with a minimum estimate of $3,219.9 billion and a maximum one of $3,740.2 billion. In short, ASD believed that no specific figure could be established and that the total cost of only two production runs of the C–5A would fall between the two estimates, a margin of roughly $500 million. The carefully hedged estimate seemed to suggest the division's uneasiness in coping with both anticipated increases in airframe weight and Secretary Charles's new procurement procedure.[61]

The Air Force knew all too well the problems inherent in airframe weight increases. Such problems, like some of the procurement failings identified by Assistant Secretary Charles, might also prove unexpectedly difficult to eliminate. Indeed, the terminology of procurement underscored the difficulty. The development of any given weapon system stemmed from initial requirements, put out by the armed services and promptly endorsed by eager manufacturers. The requirements, however, because of their initial or tentative nature, needed refinement. Even as they called for changes, the military services tended to become complacent because contractors chose to ignore or minimize the impact of these numerous modifications until the service became irrevocably committed to the development or production contract. Like the other armed services, the Air Force had repeatedly but unsuccessfully tried to solve the problem. Of course, the fault often lay with the purchaser, as in the case of the Boeing B–47, when the Air Force rushed production while simultaneously imposing a multitude of new requirements on the prime contractor. Similarly, the Air Force made unrealistic demands on the builder of the B–58, thus contributing to slippage of the IOC and high cost.[62]

Whatever the aircraft, weight increases tended to snowball, as they reduced performance by increments. The easiest solution to added weight consisted of substituting more powerful engines. In the case of the C–5, however, development of a new engine would be a time-consuming and costly undertaking, and increasing the power of an engine not yet tested verged on the impossible. Moreover, any substitution of a different powerplant created new problems. Equipping an overweight aircraft with better or more numerous engines raised fuel consumption, thereby increasing operational costs and reducing range; whereas performance usually improved, the weight of extra fuel further taxed the aircraft structure and decreased its payload. Hence, extensive and expensive structural modifications became necessary before, during, and after the initial production run of a new or greatly improved aircraft. On occasion, a similar investment became necessary years later to extend the plane's operational life. In either case, unavoidable modifications generated very substantial profits for the aircraft industry.[63]

The history of aircraft procurement persuaded the Air Force to give total-package

procurement a try. The odds of success seemed good, for the C–5A was not expected to require technological advances too bold for the new contractual arrangements. Believing it had thoroughly explained its requirements for a cargo plane during the preceding CX–X and CX–HLS projects, the Air Force had become confident that the C–5A embodied the desired performance and could be developed with a reasonable expectation of success. In addition, the new procurement concept that Charles backed might satisfy an Air Force goal of long standing by requiring "a tightening of design and configuration discipline, both in the specifications on which the competitors will submit proposals, and in the work under the contract." Since they were committed to cost and performance figures for production aircraft before detail design began, all the competitors would be motivated to come up with a design that would result in an aircraft economically produced, reliable, and easy to maintain. All aspects of such a design would be directly influenced by actions taken "right from the start" of the detail design period, whereas past procurement procedures had consistently failed to assert influence so early. In final analysis, however, the key to the C–5 or any airplane of its extraordinary size and weight had to be its engine. Without adequate thrust the future transport aircraft could not go anywhere.

Weight: A Frustrating Start

Shortly after release in December 1964 of the request for proposals, the Air Force optimism turned to consternation as program officials realized that the C–5A was gaining weight. Weight had several aspects, the most basic among them being gross weight, the total weight of a fully loaded aircraft, also known as take-off weight and including the "dry weight" of the aircraft plus the crew, fuel, and payload. Operating weight, or operating weight empty, included the basic dry weight of the airplane plus the weight of the crew, oil, crewmen's baggage, stewards' equipment, and any emergency or extra items that might be required; it excluded any ammunition on board and the weight of fuel, whether in external or internal tanks, along with the fire-suppressant added to the fuel. Gross weight lay at the heart of the C–5A's problem.

The conceptual, parametric studies of June 1964 had predicted that gross weight would range from 645,000 to 681,000 pounds, and the Air Force assumed this figure would be incorporated in the operational requirement. Yet, in the rush to release the requests for proposal, errors occurred. Items that were part of the aircraft's operating weight empty were not properly labeled and were now showing up in the gross weight, where they proved to be "the major cause of increased weight." The items omitted, known in Air Force terminology as "dead weight items," included ramps, doors, lights, tools, equipment tie-down chains, and war readiness material (WRM) kits. Also included were the aircraft engines, provisions for benches or individual seats for twenty flight deck personnel, and a special removable deck above the cargo floor for eighty-seven troops. By 1965, the contractors realized that their proposals had not taken into account all requirements and began to acknowledge weight increases which, to the dismay of the Air Force, would bring the aircraft gross weight to about 700,000 pounds. In other words, while the Air Force grappled with one weight increase, another one was taking shape. Frenzied activity ensued, as harassed program officials sought to reduce the C–5A's burgeoning weight.

Reducing the weight of any kind of aircraft always posed a challenge. In the case of the future C–5A, it was particularly difficult because the number of engines fluctuated from four to six as the Air Force refined the concept. The difficulty became evident in the request for proposals of December 1964, which asked for a minimum engine thrust of 40,000 pounds

but did not list definite design characteristics, such as bypass ratios and specific fuel consumption.

On January 24, 1965, ASD established an ad hoc weight control group of seven engineers, but raised this total to twenty soon afterward. The engineers, most of whom were weight control specialists, concluded that requirements in the request for proposals had increased the airframe's dead weight by 16,799 pounds or roughly eight tons. Since the review deleted no more than five "dead weight" items—those that did not contribute to aircraft performance—for a meager decrease of 950 pounds, the only remaining solution lay in tradeoffs, in effect adding to one category while subtracting from another. Hence, such dead weight items as equipment tie-down chains, accommodations for troops, and aft toe ramps would be counted as part of the aircraft's payload and included in its gross or takeoff weight. Obviously, shifting weight from one category to the other would have no effect on the aggregate weight, but just the same, the solution had merits. Transferring removable dead weight items to payload would cut the aircraft operating weight empty by some 8,000 pounds. This redistribution and an 8,000-pound reduction of the payload suggested by the December 1964 request for proposals would eliminate the 16,799 pounds identified by the ad hoc group of engineers and bring the maximum weight of the C–5A to an acceptable level. Moreover, elimination of the eight tons would lower fuel consumption, thereby opening the way for an additional weight reduction by decreasing the aircraft's fuel load. Of course, the tradeoffs would benefit some missions more than others, when, for example, the aircraft need not carry all of the equipment now shifted to the payload category, or when it would fly out empty to pick up cargo.[64]

The approved tradeoffs reflected the original Air Force concept of plane designed expressly to carry cargo. The tradeoffs came into conflict, however, with public statements by high-ranking officials and Air Force public information officers to the effect that "the C–5A should be able to lift 600 or 700 troops up to 7,000 miles at over 500 miles per hour." To make matters worse, Secretary McNamara, on the basis of erroneous Air Force data that ignored the weight reduction tradeoffs, told a television audience that the C–5A could accommodate 700 civilians or 600 fully-equipped troops. Although potentially embarrassing, the claims were promptly put to rest as semantic errors, a fair explanation in light of the official changes presented to the contractors in the spring of 1965.[65]

On March 23, 1965, the Air Force scaled down contractor requirements by issuing a change notice to the request for proposals of December 11, 1964. The new document, included in ASD's cost study that Secretary Zuckert had requested months before, reflected the recent engineering study and the paper weight model, as it sought to reduce weight. The ASD engineering study and paper weight model, however, were essentially management tools. As a result, the change notice explicitly told the contractors that palletized seating for additional troops, to be installed on the main cargo deck, should not be included in the aircraft basic weight, because it would only be installed for emergency operations. To avoid further misunderstandings on the part of either industry or the government, it specified that the Air Force did not plan to use the C–5A on multi-purpose missions to transport substantial numbers of paratroopers or passengers and had "no firm requirement" for either more emergency exits or additional doors for paratroop jumps. The change notice also informed the contractors that the aircraft payload was to be defined as deliverable cargo, a category that excluded the removable seats or other accommodations for troops, WRM kits, pallets, tie-down nets, tie-down chains in excess of 1,750 pounds, and rear toe ramps, unless the item was actually on board. Finally, the contractors were directed to accept a higher temperature in the cargo area while the plane was on the ground; this change in air-conditioning would

save the weight and the cost of an auxiliary power unit.[66]

Despite these efforts, weight remained a problem. Even after the signing of the C–5A contract in late 1965, General Schriever continued to express concern, commenting that, if necessary, lighter and stronger synthetic materials should be selected and more efficient structural design achieved to reduce weight wherever possible. Schriever retired as AFSC commander on August 31, 1966, long before the problems with the C–5A received public attention. As a staunch proponent of decentralization, he would remain convinced years later that the concept of total-package procurement endorsed by McNamara had been faulty. Others, however, would argue that the C–5A's most serious problems stemmed from the Air Force's insistence on original weight specifications and Lockheed's unwise structural changes to meet them.[67]

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CHAPTER III

BUILDING THE C–5A: PROBLEMS AND CONTROVERSY

Total-package procurement imposed special requirements on the acquisition process for the C–5. For example, new procedures governed selection of the contractors. To begin with, Secretary of Defense McNamara delegated selection authority to Secretary of the Air Force Zuckert—an authority rarely exercised by a service secretary since the mid-1950s, especially during the McNamara years, 1961-1968.

McNamara's seven-year tenure witnessed a succession of major events, notably the beginning and escalation of the Vietnam War. Some of McNamara's personal contributions to the Presidencies of Kennedy and Johnson, although highly controversial, withstood the passage of time, lasting through the 1980s and into the 1990s. Among other things, his overhaul of the airlift forces and acquisition of the C–5 had long-lived consequences. Moreover, McNamara's handling of President John F. Kennedy's strategy of flexible response, in which airlift and the C–5 played a critical part, showed an uncanny perspicacity and a noteworthy wisdom.[1]

President Kennedy's national policies basically followed those of Truman and Eisenhower, particularly when it came to fiscal restraint. Kennedy, however, emphatically rejected President Dwight Eisenhower's continued strong reliance on nuclear weapons, a strategy actually rooted on the Truman Presidency.[2] In the late 1950s, the Army Chief of Staff, Gen. Maxwell D. Taylor gained increasing support for the concept of flexible response, causing Eisenhower and his Secretary of State, John Foster Dulles, to reconsider, though not abandon entirely, their reliance on nuclear deterrence. They agreed that the increased power of the Soviet Union's nuclear arsenal, along with its American counterpart, might cancel each other and increase the likelihood of so-called wars of liberation or limited wars.[3] Between 1958 and 1962, a series of crises in Lebanon, the Congo, Berlin, and Cuba underscored the risk of direct military confrontation with the Union of Soviet Socialist Republics.[4] In any case, before the Lebanon landing, the Eisenhower Administration had not shared Maxwell Taylor's opinion that using atomic tactical weapons against military targets in any limited war "would be more likely to trigger off a big war than the use of twenty-ton block-busters."[5]

In 1961, upon ascending to the Presidency, Kennedy faced many problems. As the Soviet Union's strategic nuclear arsenal grew, the American homeland was becoming more vulnerable to a devastating surprise attack. Such an occurrence appeared unlikely but remained a possibility several decades later. In the 1970s and early 1980s, according to one scholar, David Alan Rosenberg, the United States government believed that a major nuclear exchange would bring mutual disaster. Both nations "would suffer very high levels of damage and neither could conceivably be described as a `winner'. This was true regardless of who strikes first.... Whether the attack is a surprise and regardless of the targeting policy adopted by either side."[6] Fatalities would be so high (over a million in each country) that neither could risk an all-out war. Should the Soviet Union attack Europe with a conventionally-armed horde, Kennedy believed that flexible response might be the answer, but in a different form than the Eisenhower administration had planned. Moreover, Kennedy, like Maxwell Taylor, realized that Soviet-sponsored wars of liberation were likely to erupt and that attempting to fight them with tactical nuclear weapons would result in rapid escalation. Nevertheless, keeping the Warsaw Pact conventional forces uncertain as to the possible use of tactical nuclear weapons would complicate Soviet planning. For these reasons, Kennedy instructed Secretary of Defense McNamara to define the new strategy. McNamara codified the American

proposals and presented them to the European allies in 1961 and 1962, but the Europeans did not accept flexible response until 1967.[7]

As McNamara quickly discovered, defining flexible response, as requested by President Kennedy, was far easier that drafting a policy acceptable to the other nations of the North Atlantic Treaty Organization (NATO), for all the nations had different requirements. The British government, for example, recognized the need to provide conventional forces capable of responding, without using nuclear weapons, to a major attack by the Warsaw Pact, but Great Britain thought that the NATO build-up had to be very modest given the low likelihood of such an attack. The Germans also recognized the need to provide for a conventional response in certain limited circumstances but, in final analysis, "found it as undesirable because it suggested a weakening of the nuclear deterrent and a willingness to fight a long conventional war on European territory."[8] As the principal American advocate of flexible response, McNamara exercised masterful ambiguity, enabling the European allies to interpret Kennedy's policy as they saw fit. the only exception being France. The Secretary of Defense rarely displayed such diplomacy; he showed greater patience with the rigidity of foreign governments that with opposition from Congress or the American military.[9]

In early 1958, rebellion in French North Africa toppled the government at Paris, and Gen. Charles de Gaulle became prime minister with extraordinary powers. In December of that year, he was elected president of France, which gave him the opportunity to achieve goals that he had been nurturing for years, few of which were likely to please the United States. The Suez Canal crisis of 1956, when Eisenhower had forced France and Great Britain to cease operations to recapture the Suez Canal from Egyptian forces, convinced de Gaulle that French interests often conflicted with those of the United States. The crisis, which humiliated both the United Kingdom and France, revived de Gaulle's bitterness toward the United States, which dated from perceived slights during World War II.

Trying to sell flexible response to NATO, McNamara encountered a prickly de Gaulle determined to put French interests first. Although the American Secretary of Defense urged NATO to adopt a series of military options between nuclear holocaust and abject surrender and argued that a single authority, obviously in Washington, should control the nuclear retaliatory forces, de Gaulle continued to develop an independent nuclear force under French control. The Cuban missile crisis of 1962 seemed to confirm de Gaulle's fears that his country might well become a radioactive wasteland in the event of a third world war. In 1966, after blocking Britain's entry in the European Common Market, strengthening French ties with West Germany, and extending diplomatic recognition to Communist China, de Gaulle ordered NATO forces out of France, thus severing the air lanes upon which flexible response might someday depend.[10]

Actually, the vulnerability of the United States to the loss of overseas bases and landing or overflight rights had surfaced immediately after the fighting ended in Korea. The Air Force Chief of Staff, Gen. Hoyt S. Vandenberg, had recognized the problem when he suggested that airmobile logistics support could substitute for vulnerable depots located on foreign soil.[11]

Another problem of long standing, high on Vandenberg's list of critical priorities, still remained unsolved in the early 1960s, that of the Army's need for more airlift. In mid-1953, on the heels of the Korean Armistice, the Army Chief of Staff, Gen. J. Lawton Collins, began insisting that the Army should be made as air transportable as possible over great distances.[12] Ten years later, the Military Air Transport Services was still attempting to convince the U.S. Strike Command (STRICOM) that the airlift forces were capable of satisfying the Army's mobility requirements.[13]

Against this background, the airlift forces increased in importance, and acquiring the C–5 took on greater urgency. Luckily for the Air Force, despite the many innovations of the total- package procurement concept (TPPC), the future transport's detailed evaluation and early selection process proved fairly smooth, even though there were no precedents for the new method of procurement.[14]

Source Selection Board Proceedings

The Air Force C–5A Source Selection Board, established on November 16, 1964, consisted of senior military and civilian officials appointed by the source selection authority, Secretary of the Air Force Zuckert, formerly an assistant to Secretaries of the Air Force Stuart Symington and Thomas K. Finletter, and an acquaintance of Secretary McNamara since both had taught at the Harvard School of Business. General Terhune, Commander of the Aeronautical Systems Division (ASD), headed the Selection Board, and three general officers, one each from the air transport, logistics, and systems commands, served as voting members. The three formed what was sometimes called the management group. The Selection Board reviewed the findings of the Evaluation Group, which began its formal functions on April 20, 1965. The Evaluation Group, at one time totaling as many as 500 military and civilian experts appointed by the Selection Board, conducted a technical analysis of every proposal, determined if it met Air Force requirements, but made no recommendations. The Source Selection Board in turn examined the findings of the Evaluation Group and made non-binding recommendations of winners of the airframe and engine competitions. Gen. Bernard A. Schriever, Commander of the Air Force Systems Command (AFSC), General Howell M. Estes, Jr., Commander of the Military Air Transport Service (MATS), who had replaced General Kelly in 1964, and General Mark E. Bradley, Jr., Commander of the Air Force Logistics Command (AFLC)—the three senior commanders directly involved in the C–5A project—subsequently would inform the Air Force Council of their preferred choices, and the council would give Secretary Zuckert its recommendations which, like those of the three generals of the management group, were not binding. As a rule, the Air Force leadership accepted the council's advice without question. In the case of the C–5A, however, Secretary Zuckert bore the ultimate authority, exercising "maximum latitude in the selection process."[15]

Five airframe contractors initially competed. In June 1964, however, two of them, the General Dynamics and Martin Marietta corporations, were eliminated after submitting proposals and therefore, did not participate in the parametric studies authorized and funded by the Department of Defense in December 1963. This left a total of five competitors, the Boeing, Douglas, and Lockheed-Georgia companies for the airframe and the General Electric Company and Pratt and Whitney Aircraft Division of the United Aircraft Corporation for the engine. One of the basic provisions of total-package procurement specifically required that all five competitors sign production contracts even though only two would eventually qualify to carry them out. The contractors would immediately receive fixed-price agreements to define their preliminary but detailed systems designs, which would become government property. Although relatively small at the beginning, the C–5 contract promised to become extremely lucrative, inspiring fierce competition. Probably for this very reason, none of the contractors objected to the new competitive procedures, which obviously favored the Air Force in letting the contract. Another provision allowed the Air Force to continue defraying, at least partially, the expenses of the competitors until the final two winners emerged. On the other hand, post-evaluation payments could be stopped should the Air Force determine that a proposal did not meet established requirements.

On July 27, 1965, the Air Force Systems Command authorized weekly payments on the propulsion system contracts throughout the entire competition. The money, intended to verify engine components, would continue to be paid until the final winner was selected. As it turned out, Pratt and Whitney hardly benefitted from the post-evaluation arrangement, for Secretary Zuckert announced on August 5 that financing of Pratt and Whitney's interim contract was being discontinued. General Electric, the only rival, had won the engine competition. Official announcement, strictly a formality, would await the selection of a contractor for the airframe.[16]

The Air Force rejected the Pratt and Whitney engine for three reasons: it consumed excessive amounts of fuel; the projected cost seemed unrealistic; and the risks associated with developing specific engine components—like the high-pressure compressor, the combustor, and the high-pressure turbine—appeared prohibitive. Pratt and Whitney's president, H. E. Mallet, attempted to rescue the project with a revised proposal emphasizing logistics support, production capacity, engine weight, and ease of maintenance, but the Air Force rejected it.[17]

Selection of the airframe builder took more time than choosing a contractor for the engine. To begin with, all three contractors —Boeing, Douglas, and Lockheed—submitted enticing proposals, which arrived in April 1965. The evaluations lasted until August 18, when the deliberations of the airframe Source Selection Board ended. Five days later the board advised the Air Force Council that Boeing Airplane Company was the unanimous choice. Procedures peculiar to total-package procurement now took effect, giving the contractors the opportunity to respond to criticism from the Source Selection Board, forward their proposed changes, and sign airframe contracts prepared by the Air Force in anticipation of the final award.

Changes proposed by contractors and the attendant cost revisions, together with signed contracts, reached the Air Force on September 4, 1965. Although Lockheed submitted drawings for a highly attractive new design, source selection officials again favored the Boeing entry. In their opinion, the drastic changes outlined by Lockheed could not be made at such a late date without significant technical risk and the resulting likelihood of delays in aircraft acquisition and increased costs. The Douglas proposal fell in the same category, presenting definite advantages offset by technical risk. Once more, Boeing seemed unbeatable with the "best technically balanced design" in the opinion of the board.

Source selection officials attributed Boeing's superiority to the blown-flap, a high-lift device, that enabled the contractor to design an aircraft with a smaller wing area and lesser gross weight. The mechanism used engine exhaust gas to control the boundary layer passing over the trailing-edge wing flap, increasing lift, allowing a more satisfactory match between takeoff and cruising speeds, and enabling the plane to operate with heavier loads from short air strips. By improving lift the blown flap also resulted lower stalling speeds and safer landings and takeoffs. Despite the aerodynamic edge conferred by this device, Boeing's competitive success proved short-lived.

From the start, total-package procurement sought to insure that the unproven merits of an aircraft design that existed only on paper would not dominate the selection process. The concept tried to make costs of production, as well as logistics support of a weapon system, part of the equation. In other words, the "total package" combined technical considerations with cost-effectiveness, which McNamara began emphasizing immediately upon taking office. From this standpoint of this combination, the Lockheed proposal, regardless of its technical risks, might appear to be the best.

In estimating cost-effectiveness, the Air Force, relied on extrapolation from previous programs, taking into account inflation as well as changes in the product, to develop a so-

called "most probable cost" formula, with which to reevaluate the new figures accompanying the revised proposals. Every cost proposal envisioned a six-squadron force of 115 aircraft, in two production runs. Only the first lot, referred to as Production Run A, underwent detailed analysis. Run A totaled 58 aircraft, including five test versions that would later be brought up to operational standard. The second lot, Production Run B, would consist of the remaining 57 aircraft. The cost of subsequent purchases, should the program be expanded to 200, was not mentioned. The Air Force had not requested it, because production cost could not be estimated with any degree of accuracy so far in advance.

Lockheed, whose first proposal had been the least expensive, once again fared well, projecting a total-package procurement cost of $1.714 billion for the 115 aircraft in Production Runs A and B. For the same number of aircraft, also including research and development costs plus a target profit of 10 percent, Douglas wanted $1.793 billion and Boeing, $2.014 billion. Using its own formula, the Air Force concluded that the Lockheed program most probably would cost $1.860 billion, Douglas $2.019; and Boeing $2.055. Since the Air Force calculations did not include the target profit incorporated in the contractor figures, it was clear that not one but all of the proposals were optimistic or willfully underpriced. The proposed characteristics of the three designs proved similar enough to complicate decision-making even more, as substantiated by the following data:[18]

Characteristics of Contractors' Proposals

		Boeing
Douglas		Lockheed
Wing Area (Sq. ft.)		
5,500		6,200
		6,200
Wing Span (Linear ft.)		
		215
222.8		222.7
Acft Length (Linear ft.)		
		222
208.8		236.2
Acft Height[1] (Linear ft.)		
		68.6
70.2		58.6
Usable Cargo Area (Sq. ft.)		
		2,804
2,807		2,747
Usable Cargo Vol. (Cu ft.)		
		39,106
43,900		37,837
Operating Tare Wgt.[2] (Lbs.)		
318,768		318,529

[1] Horizontal Stabilizer neutral, landing gear in normal taxi position.

[2] Operating Tare, or "tare weight," also called "dry weight," is the weight of the airplane ready to fly, excluding crew, fuel and oil, payload, and miscellaneous consumables.

323,718

Disposable Load[3] (Lbs.) . . . . . .
. 416,232
378,171 445,282

Maximum Takeoff Wgt.[4] (Lbs.) . . . . . .
725,000 716,700
769,000

[3] Disposable load is the difference between maximum takeoff weight (MTOW) and tare weight, including the crew, fuel and oil, payload, and consumables. The payload is a fraction of the disposable load, consisting of passengers, cargo (military ordnance such as bombs or bullets), or any combination thereof.

[4] Maximum takeoff weight (MTOW), also called gross weight, includes everything. It is, however, eventually limited legally by the airplane's certificate of airworthiness, which tends to err on the side of conservatism.

Selection: The Low-Cost Bidder Prevails

After studying the findings and recommendations of the source selection officials and management group, the Air Force Council before month's end passed on its recommendations to General John P. McConnell, the new Air Force Chief of Staff, and to Secretary Zuckert. In the military services, when it came to procurement, choosing the lowest cost bidder had become almost an institutional imperative. Zuckert, who would resign from his position a few days later (September 30, 1965), did not break with this tradition, for he chose the least expensive proposal, Lockheed's, and General McConnell endorsed the decision, even though the Source Selection Board favored the Boeing entry. Lockheed won because its bid was cheaper by $300 million than Boeing's. Even General Schriever, whose misgivings over the technical risks of Lockheed's initial aircraft design were not alleviated by the contractor's revised proposal, did not criticize the selection. The only dissenting opinion, expressed openly, came from Gen. Kenneth B. Hobson who had replaced General Bradley as Commander of the Logistics Command in August 1965. As one of the three generals in the management group, General Hobson insisted that the Boeing design would yield an aircraft technically and operationally superior to other contenders at an acceptable additional cost.[19]

Unlike Hobson, General Estes, Commander of the Military Air Transport Service, was pleased with the Lockheed proposal, and his opinion mattered because the C–5A would be operated by his command. Also a member of the management group, Estes had been quite vocal in support of the Lockheed proposal, arguing that only two of the competitors deserved serious consideration because the Douglas design was "technically insufficient." Moreover, Douglas's ceiling price, including the projected profit, might be the lowest for 58 aircraft, but for 115 aircraft it surpassed Lockheed's bid by $118 million. The Boeing design, General Estes conceded, promised an aircraft faster than the Lockheed, a factor contributing to the greater cost of the Boeing airplane, but speed was not all that crucial. On the other hand, the slower but wider Lockheed configuration would make loading easier, a critical advantage as far as the MATS commander was concerned.[20]

Had Zuckert entertained any lingering doubts, the strong arguments by General Estes in favor of the Lockheed proposal would probably have put them to rest. Lockheed's cockpit design for the C–5A resembled the cockpit of the C–141, General Estes pointed out, and other components would be common to both Lockheed aircraft. As the Air Force realized, Secretary McNamara pushed commonality, along with centralized procurement, to cut costs.[21]

Other less obvious reasons may have influenced the decision in favor of Lockheed. One analyst, Rene J. Francillon, has concluded that, "geopolitical considerations" may well have been the decisive factor in awarding three equally large contracts in 1965 and 1966. Francillon identified the three potential contracts. Douglas and Lockheed in California, and Boeing in the state of Washington competed for the Manned Orbiting Laboratory (MOL) and the Supersonic Transport (SST). Boeing and Douglas, joined by Lockheed-Georgia rather than Lockheed's West Coast operation, went after the C–5A. Each of the parent firms got one of the three: Douglas and the state of California won the MOL contract; Boeing and the state of Washington received the SST; and in October 1965 Lockheed- Georgia became prime contractor for the C–5. This last award came at a critical time because C–141 production was coming to an end, threatening to shut down the enormous, government-owned Marietta plant, which Lockheed leased, and deliver a damaging economic blow to the state of Georgia. Whatever the merits of Francillon's analysis, the two West Coast contractors suffered unexpected setbacks, for both the MOL and SST contracts were subsequently canceled

because of the high cost of President Johnson's deepening involvement in Southeast Asia, which, ironically, underscored the need for the C–5.

Whether politics, as Francillon claimed, or cost-effectiveness justified the choice of a contractor, on September 30, 1965, Secretary of Defense McNamara publicly announced that Lockheed had won the airframe production contract and that the total cost of the program's first increment—the 58 aircraft of Production Run A, the only C–5s covered by a firm commitment—would amount to about $2 billion, $1.4 billion for the airframe and $600 million for the General Electric engine. Compared with Lockheed's firm quote of $1.7 billion for a 115 aircraft program (Production Runs A and B), the McNamara estimate seemed high, even taking into account, as the Air Force had, that the bids submitted by the three airframe contractors were surely underpriced, and perhaps higher still, if General Terhune were correct in pointing out that the first aircraft built, Production Run A, would be the costliest and that quantity production would reduce the unit cost.[22]

The Secretary of Defense in his public announcement described the immense size of the C–5A, which would be more than 200 feet long and 63 feet high at the tail, with a wing span of 220 feet. Maximum takeoff weight (MTOW) would probably exceed 760,000 pounds. The new transport, Secretary McNamara added, would enhance dramatically Army mobility during crises and decrease the time required to move large numbers of American forces anywhere in the world. McNamara further stated that the C–5A would be much faster than any Soviet cargo aircraft, though speed was not a primary requirement, and have twice the capacity of the Soviet Antonov An-22 cargo plane. The characteristics described by Secretary McNamara proved generally accurate as far as size was concerned, though the finished product proved longer, 245.9 feet, and the tail higher, 65.1 feet. When he spoke of carrying troops, however, the Secretary of Defense was wrong, for he used erroneous data provided by the Air Force. Instead of shuttling large numbers of soldiers throughout the world, the C–5A would carry cargo almost exclusively; it could accommodate only 75 troops in an emergency.

On October 11, 1965, Maj. Gen. Harry E. Goldsworthy, Director of Production and Programming, DCS/Systems and Logistics, authorized AFSC to enter into a contract with Lockheed for the C–5A. This was less than two weeks after Secretary McNamara's public announcement of September 30, and the contract retained the official date of October 11, even though Lockheed did not sign it until December 17.[23] Between October 11 and December 17, Lockheed officials asked for a new delivery schedule, among other changes. The original schedule prescribed for the contract competition specified an initial operation capability in 1969 and deliveries timed to meet this deadline. One aircraft was scheduled to reach the Air Force in June 1969, one in July, two in August, and three each month from September through December. To be on the safe side, the Air Force stipulated that the winning contractor would be liable for a daily penalty of $12,000 per aircraft not delivered by the end of the specified month. This so-called "Liquidated Damages Provision" applied only to the first 16 aircraft scheduled for delivery (test aircraft excluded) and the maximum penalty was $11 million. These provisions appeared in the contract signed by all competitors, and Lockheed, upon submission of its revised proposal, again accepted them without argument.[24]

There arose other portents of the many difficulties that soon beset the program. Besides trying unsuccessfully to change the schedule, Lockheed also attempted to lower the performance figures for its revised design, even though the Air Force had insisted that any contractor-proposed performance characteristics, which exceeded established operational requirements, would automatically become the guaranteed minimum. Finally, Lockheed also challenged the contractual provisions covering the propulsion system. The Air Force would

purchase the C–5A engine and provide it to the airframe contractor as Government-Furnished Equipment (GFE). The engine had to meet performance specifications, determined during the program definition phase, before the Air Force handed it over. Thereafter, Lockheed had to assume full responsibility for the overall performance of the integrated system. Although all parties had agreed on this approach, Lockheed now wanted to negotiate a separate agreement with General Electric, making the engine contractor responsible for the integration as well as the performance of the powerplant and its many components. Understandably, General Electric wanted no part of Lockheed's new scheme.[25]

Buttressed by its legal staff, the Air Force stood firm and on December 16, one day before signature of the contract, Lockheed gave up asking for changes. There were two possible explanations for Lockheed's apparent surrender. One attributed it to the fact that 1965 was not a good year for the military aircraft industry in general and for Lockheed in particular. Production of the C–141 at Marietta, Georgia, was about to end and Lockheed had no comparable order to take its place. Nor had the firm developed commercial jets to compete with the Boeing 707 and Douglas DC–8. As a result, Lockheed badly needed the C–5A program to stay abreast of its two rivals. In addition, the new contract might provide a windfall if Lockheed could develop and market a civilian version of the C–5A.

The other explanation, which did not surface until much later, focused on a little-noticed concession that Lockheed had received, the so-called repricing or reverse-incentive formula. Largely unnoticed at the time, the repricing formula had the potential for undoing many of the reforms set forth in total-package procurement. In short, Lockheed stood to gain far more from repricing that it could have obtained from the contractual changes it had sought and then abandoned.

Thomas R. May, Vice President of Lockheed-Georgia, announced that the C–5A, like the C–141, would be built at the Marietta plant. He offered assurance that Lockheed would honor its commitments, comply with Air Force contractual provisions, and at no extra cost to the Air Force integrate the General Electric engine into the modified Lockheed design. Evidently, the Air Force had won the first round, but thanks to repricing one round could not ensure victory.[26]

Under the total-package procurement concept—at least until the use of the repricing formula—the fixed-price production contract for the airframe, signed by all competitors in anticipation of the final award, contained a flexible incentive formula based on sharing costs, above or below the target, at a ratio of 85 percent by the government and 15 percent by the manufacturer. Because ASD's Cost Evaluation Group concluded that estimates by all the competitors were too low, a clause enabled the Air Force to substitute a less generous fixed-priced incentive fee (FPIF) contract, with the government and the manufacturer sharing evenly all costs below the target. For costs in excess of the target, the government would assume responsibility for 30 percent and the contractor for 70 percent. Moreover, under the FPIF option, the program's target cost and ceiling price could increase by only 3.2 percent. Convinced, like the ASD Cost Evaluation Group, that Lockheed's winning low-cost bid ($1.7 billion for 115 aircraft) was unrealistic, Secretary of the Air Force Harold Brown, Zuckert's successor, invoked the FPIF option on December 31, 1965, three days ahead of the specified deadline. Substitution of the stricter FPIF for the flexible incentive caused Lockheed to increase the target cost from $1,714 million to $1,768 million, the target profit from $172 million to $177 million, the target price $1,896 million to $1,945 million, and the ceiling price from $2,229 million to $2,299 million.[27]

Brown seemed to share McNamara's lack of confidence, not so much in the total-

package concept as in its practical application. In 1964, while serving as Director of Defense Research and Engineering, Brown had pointed out that if the new procurement technique failed, the Air Force could return to a more traditional method. This comment may have foreshadowed his willingness to chose the FPIF option and, perhaps, Schriever's continuing search for means of reducing weight after the total-package contract had been signed with Lockheed.

The FPIF option, adopted by Brown in late December 1965 and incorporated in the basic airframe contract, AF 33 (657) 15053, shortly before Lockheed signed the agreement, seemed ideal for total-package procurement. The fixed-price-incentive-fee approach sought to encourage Lockheed to cut costs while meeting performance guarantees. Ordinarily, the incentive feature might apply to performance and production, as well as costs, but not so with the C–5A, since the total-package contract already covered these elements.

Except for the inclusion of a 3.2 percent increase in both the target cost and the absolute ceiling price—the latter originally set at 130 percent of the target cost—all the provisions originally spelled out for the three competitors survived intact. For example, the target cost included 10 percent profit, and any costs above the absolute ceiling price would be borne entirely by the contractor. Although the bids covered 115 aircraft, the costs had also been estimated for each of the two production runs. In addition, the Air Force prorated program costs according to production norms. Hence, the price of the first 58 C–5A aircraft (Production Run A) was much higher than the price of the second 57 Run B planes, as General Terhune had suggested.

Unfortunately for proponents of the C–5A program, the contract also included the repricing formula designed to limit the losses Lockheed seemed certain to incur as the result of its unrealistically low bid. In effect, repricing functioned like a flexible-cost incentive formula, which the Air Force had ruled out for the C–5A. Under certain circumstances, the repricing formula could increase enormously the price of a least a portion of Production Run B, presumed to be less costly than the initial production run.[28] . . . .

The repricing formula, introduced probably in late 1965 by Robert H. Charles, Assistant Secretary of the Air Force for Installations and Logistics, undercut the total-package procurement concept that he personally championed. Despite this contradiction, the repricing formula became part of Lockheed's contract, replacing a flexible-incentive option and remaining in the FPIF arrangement. The repricing formula would take effect should the actual cost of the first 58 C–5As (Production Run A) exceed 130 percent of the target cost. Moreover, Lockheed's potential gain could be stupendous, up to $2.00 for every dollar spent—a profit that might well tempt the contractor to increase costs deliberately.[29]

On the other hand, some provisions of the contract mitigated the formula's potential impact. For example, should the price of the first 58 C–5As increase sufficiently to trigger the repricing formula, the price adjustment generated by the formula could not be added to these 58 aircraft (Production Run A) or to the first 32 aircraft of the 57-plane Production Run B, the balance of the 115 C–5As the Air Force was buying. In other words, any upward adjustment justified by the repricing formula would not apply to the first 90 C–5As. Moreover, the government's liability under repricing could not exceed the ceiling price of Production Run A, and the contract could be terminated at the government's convenience, "in whole, or from time to time in part," by written notification. The clauses limiting liability and permitting cancellation sought to dissuade the contractor from padding costs for Production Run A, since the government might cancel subsequent purchases leaving Lockheed to pay half the cost overrun on the aircraft already built. The contractor might run the risk, gambling that the government lacked the resolve to stop production and would keep on paying the bills. Except for Assistant Secretary Charles, a handful of procurement experts,

and some persons closely involved in the contract's final negotiation, including high ranking personnel of the C–5A Project Office, few government officials either knew of the repricing formula or realized its implications until too late.[30]

Historically, almost every weapon system encounters problems during the development cycle. A consensus existed, however, that the C–5A was "within the state-of-the-art," and Lockheed had emphasized the future transport's relationship to the successful C–141. Compared with the C–5, the C–141 was much smaller in volume, about 100 feet shorter, and almost 200,000-pounds lighter when empty. Moreover, the maximum takeoff weight of the C–141 was half the C–5A's MTOW of 769,000 pounds. The critical difference lay in the larger volume of the C–5A, which affected fuel consumption, range, and other performance characteristics. As Richard K. Smith has pointed out, every plumber knows that doubling the diameter of a pipe quadruples its volume, a principle that aeronautical engineers failed to apply in their comparison of the two transports. Even under the best of circumstances, a straight forward "scale up" of the C–141 to a C–5A, though viewed by many as such a simple evolution, would not be an easy task. Yet, Lockheed, by all accounts, remained highly optimistic, an attitude that reflected miscalculations, poor judgment, or perhaps bad faith. For the present, however, Lockheed's demonstrated success with cargo aircraft and its manufacturing skill lulled the Air Force into underestimating the magnitude of the task. Nor did the Air Force foresee the financial loss and bitter polemics caused by severe problems in developing the aircraft.[31]

In early 1966, wind tunnel tests showed that aerodynamic drag—to which the large volume of the fuselage had contributed—would prevent the C–5A from meeting contract performance specifications. Corrective action, including structural modifications to accommodate more fuel, actually worsened the problem by increasing the aircraft's empty weight well above the guaranteed maximum of 318,469 pounds stipulated by the airframe contract of October 1965. By the end of 1966, after altering the basic design of its airplane, Lockheed recognized that further changes would have be needed to keep the empty weight within allowable limits.

The ASD project office endorsed Lockheed's decisions, but approval was automatic, a mere formality, and not the result of an analysis of the impact of the changes the contractor was proposing. This response by ASD reflected the principle of total-package procurement and the contract with Lockheed, which gave the contractor total responsibility for the transport's performance. In fact, Col. Guy M. Townsend, C–5A program director after September 1965, assured Lockheed that, "We have no desire to inhibit in any way your freedom of action to perform within the scope of the contract." In March 1966 Townsend reaffirmed that, under the terms of the C–5A contract, the Air Force would neither have to "approve," nor "concur with" new courses of action. Indeed, Air Force officials seemed to have paid scant attention to Lockheed's difficulties until the spring of 1967, when the contractor's cost overruns presented a problem they could no longer ignore.[32]

Engine Development: Difficult at Best

As a rule, designing and building a new engine takes more time that the same process for an airframe. The engine, after all, serves as the very heart of the airplane for which it is designed, whether a bomber, a fighter, or a gigantic new transport. Therefore, even though the General Electric total-package procurement contract (AF33-657-15003) closely resembled one awarded Lockheed for the airframe, the Air Force handled the two differently.[33]

The Air Force played a more active part in development of the engine for the C–5A,

since it would supply the powerplant to Lockheed as government-furnished equipment. The Air Force therefore had to make sure that the engine met all technical specifications, and was delivered in time for Lockheed to meet its production schedule. The total-package procurement concept did not appear to present a challenge for the Air Force, because the General Electric engine appeared well underway. The company had been working for years on a high-pressure-ratio turbojet engine with some 50 percent greater airflow capacity than the J85. Designated the GE-1 and originally intended to power a subsequently canceled vertical takeoff or short takeoff and landing aircraft, the engine underwent successful testing in November 1963 and became the basis for the demonstrator engine for the C–5A. Starting with the high-pressure spool of the GE-1 for its C–5A demonstrator, General Electric added a front fan to provide a high bypass ratio and increased the pressure ratio and turbine temperature. The resulting operating cycle reduced fuel consumption. Still, except for new cooling techniques in the turbine area, the demonstrator engine, designated the GE-1/6, drew heavily on design features of the proven GE J79 and J93 engines. Initially run in December 1964, the GE-1/6 engine had a nominal by-pass ratio of eight to one. After several months of highly successful testing, it won the engine competition and was used to develop the high-bypass-ratio, 41,000 pound-thrust TF39 axial flow turbofan engine initially earmarked for the C–5A. Later, following extensive modifications to the wing, the C–5A would acquire the heavier but more dependable engines fitted from the start in the C–5B.[35]

Indeed, Service did not expect any unusual problems with the large, engine. The company[34]

As should have been expected, the early testing revealed various technical problems. In January 1966, the first full-scale engine, after just three hours of accumulated testing time, failed because of a faulty bearing retainer. When testing resumed, the re-built engine lost three first-stage turbine blades when fatigue cracking appeared at stress concentration points. Other technical problems arose, and sometimes the Air Force caused delays. For example, General Electric made it clear early in 1966 that it needed to know before April of that year which model B-52 would serve as the engine test bed. The Strategic Air Command (SAC) proved willing to part only with a B-52B, even though C–5A engineers insisted that the bomber would not meet the required flight criteria because its aging structure imposed restrictions on speed. Not until the end of May 1966 did SAC agree to release in October a faster, more modern B-52E.[36]

The first successful flight test of the TF39 engine in the B-52E test bed did not occur until June 29, 1967, several months behind schedule. However, the impressive flight lasted an hour and 45 minutes, producing thrust levels equal to two J57 engines at takeoff power, as the powerplant performed at 5,000 foot intervals up to an altitude of 35,000 feet. Numerous other flight tests conducted throughout the rest of 1967 yielded equally encouraging results. During a six-hour flight in late September, for instance, the engine functioned perfectly at 30,000 and 40,000 feet, attaining speeds from Mach 0.43 to 0.89. During another flight, the engine maintained 100 percent of its expected fan speed at 50,000 f e e t .[37]

Amid these accomplishments, some difficulties arose over which the contractor had no control whatsoever. For example, the Air Force's Arnold Air Development Center, near Tullahoma, Tennessee, began modifying a test cell to accommodate the TF39 in June 1966. The modification, expected to take a year, was necessary because no test stand in the United States was large enough to handle so huge a huge turbofan engine. The Air Force, however, did not complete the test stand until December 1967, despite the urgency. The complexity of the Arnold Center's new test cell, plus the scarcity of electric motors with sufficient

horsepower to satisfy testing criteria, accounted for the six-month slippage.[38]

An Old, Familiar Pattern

As approved by Secretary of Defense McNamara in February 1965, the contract for the purchase of 115 Lockheed C–5A aircraft—Production Run A, 58 aircraft, definitely on order, with a firm option for Production Run B, another 57 planes—called for an aggregate payment of $3,388.23 million. In October, the C–5A Program Office raised this figure to $3,388.23 million because this higher amount seemed a better estimate of ultimate cost of developing the airframe and engine. As the year 1966 began, the Air Force reduced the new total by $159.84 million to a maximum of $3,228.39 million. In the ensuing months, both Lockheed and General Electric started reporting unexpected increases in their overhead expenses for such things as personnel insurance, and heating and air-conditioning of buildings. The use of premium overtime, which required an extra 10-percent pay differential for work performed between 6 p.m. and 6 a.m., also raised costs. Other less clearly defined sources of cost increases included the purchase of engineering data and rising costs of sub-contracting. To maintain schedules, in 1966 concerned only with Production Run A, Lockheed needed more money.[39]

Daunted by the thought that Secretary McNamara might very well cancel the Production Run B should the C–5A fail to meet its operational deadline of 1969, the Air Force in February 1965 endorsed the estimate of $3.3 billion for a program totaling 115 C–5As. This action coincided with official approval of total-package procurement but occurred one month before the official release of the one-year cost study sponsored by Zuckert. The 115 aircraft included five test aircraft from among the 58 C–5As of Production Run A; these would later be modified to operational standard. Whereas Air Force headquarters spoke of 115 aircraft, the Aeronautical Systems Divisions referred to a total of 120. How had this discrepancy occurred?

The Aeronautical Systems Division explained the different totals by pointing out that the Air Force, until total-package procurement went into effect, had planned to follow traditional procurement procedures in acquiring its new cargo plane, which became the C–5A in December 1964. Under the old method, the Air Force would have bought five prototypes, tested and evaluated them, and then purchased 115 production aircraft from the same contractor. Hence, ASD, after excluding some $52 million in research and development funds for fiscal years 1964 and 1965, assumed that the program's $3.3 billion total cost had been based on the procurement of 120 aircraft, including the prototypes.

Air Force headquarters apparently saw no reason to change the cost of the program approved by Secretary McNamara in December 1964, and the definitive budget document, which reflected total- package procurement, carried the same price tag of $3.3 billion. The Air Force adopted the budget document during the summer months of 1965, and the Department of Defense accepted it in late September. The subsequent contract with Lockheed on October 11 covered only the first increment—the 58 C–5As of Production Run A,—of the budgeted total of 115 C–5As, test aircraft included. The Air Force justified retention of its $3.3 billion overall cost by reasoning that it was no longer purchasing "test aircraft," as under the old system, "but rather test data to validate" the designs previously developed.[40]

Linking the 120 aircraft to money, as the Air Force apparently did, seemed logical. After all, the $3.3 billion program cost was a mere estimate at the end of 1964, and total-package procurement, if actually tried, might or might not reduce anticipated program costs. Indeed, as late as March 1965 analysts at the ASD, troubled by weight increases in the

airframe and unfamiliarity with the total-package concept, could no do more than predict that the cost of 115 aircraft would vary between $3.2 billion and $3.7 billion. The Air Force's retention of the 120-aircraft total, whereas Secretary McNamara insisted that the program called for 115, did not result in clash within the defense establishment. Clearly, the Department of Defense would not challenge an Air Force program already approved by Secretary McNamara; for example, the repricing formula escaped notice. Perhaps the Lockheed contract reflected enough of the vagueness of the budget document to justify the Air Force's thinking in terms of test aircraft in lieu of test data. On the other hand, if significant cost overruns should occur, as the Air Force apparently thought likely, the cost increases would be minimized if spread over 120 aircraft instead of 115—an obvious advantage when trying to satisfy Secretary McNamara's demand for cost-effectiveness.

Obviously, juggling the numbers of aircraft could not eliminate the financial crisis that surfaced in 1966, but the Air Force worked out a solution for the initial shortfall in funding. Since the research and development (R&D) funds for the C–5A were used up, except for the amount reserved for basic tools, the Air Force shifted tooling funds to the procurement account for Production Run A. The funding shift released $104 million to pay for the extra expenses through June 30, 1966, a diversion that raised actual R&D costs beyond $210 million by the end of fiscal 1966 but in doing so solved the problem at hand. Elmer B. Staats, Comptroller General of the United States, subsequently warned the Air Staff that the one-time shift of $104 million did not create a precedent. Later, in the midst of the C–5A controversy, the Air Force was strongly criticized because it did not ask Lockheed to segregate genuine tooling costs from R&D tooling funds shifted to Production Run A. This was a serious oversight since any increases in the cost of Production Run A would alter the cost of subsequent production runs.

Late in January 1967, Lockheed again asked for more money, an additional $79.26 million above and beyond the funding contained in the contract for fiscal 1967. The firm needed the additional money by late February in order to continue working through June 30, 1967, the final day of the of fiscal year. The Air Force, after withdrawing funds set aside for profits in fiscal 1967 that the contractors had not earned, managed to provide the necessary funds, bringing total expenditure for the 12-month period to $667.1 million—almost $80 million over the established budget.

Cost increases during the procurement cycle were nothing new, but the additional sums sought by Lockheed proved mind-boggling on two counts: first, because of the amount involved; and, second, because in total-package procurement contractors were expected to deal with setbacks, financial or otherwise, without seeking relief from the buyer. Not surprisingly, when appearing before a Senate subcommittee in connection with Department of Defense appropriations for fiscal 1968, Secretary McNamara had some explaining to do before an unsympathetic audience.[41]

Secretary McNamara's centralization of authority in the hands of civilians—especially in his own hands and those of his program analysts—made him no more popular with the Congress at large, abounding in supporters of the military establishment, than he was with high-ranking uniformed officers. In addition, the Secretary's efforts to close military bases he considered superfluous did not increase his popularity among those members of Congress whose home districts lost the installations. Military bases, like weapons manufacturing, meant jobs. Representative Mendel Rivers a South Carolina Democrat and since 1965 Carl Vinson's successor as Chairman of the House Armed Services Committee, pushed hard for Air Force's new transport, in part, perhaps, because MAC had a major base in his district. Rivers, however, remained an implacable foe of McNamara, who nevertheless earned the

respect Presidents Kennedy and Johnson. Indeed, McNamara served as Secretary of Defense for seven years, exerting a powerful influence at least through 1965, but when his authority began to fade, largely because of his disillusionment with the Vietnam War, it faded quickly.[42]

Although Secretary McNamara did not resign until February 29, 1968, he may already have been on his way out when, on January 25, 1967, he testified before a Senate subcommittee on the status of the C–5A. Although the bitterest controversy lay in the future, the aircraft's mounting development costs were already causing great concern. Outwardly unperturbed, the Secretary explained that: "The cost estimates for this airplane were not satisfactory. We knew it before the contract was let." McNamara further pointed out that a spokesman for one of the contractors participating in the C–5A competition was quoted by a news magazine as admitting afterward that "it was a liar's contest," and had always been a "liar's contest," when the airframe and engine manufacturers were dealing with the government. Although total-package procurement in its first application may not have eliminated unrealistic bids and inflated claims of performance, McNamara believed the new method of procurement had served warning on the aircraft industry that "the moment of truth" was at hand. In October 1967, the C–5A program's appropriation for fiscal 1968 was set at $735.67 million, but this apparently successful outcome actually represented the calm before the storm.[43]

A Tortuous, Downhill Road

In March 1967 the Air Force notified Lockheed that the C–5A contract would be canceled if the firm did not cure the airplane's ongoing technical ailments, many of them related to weight. Issuance of a so-called "cure notice" was a rather drastic measure, seldom used by the Air Force. In any case, the Air Force's toughness received no publicity. Moreover, Air Force contract summaries and management reports began omitting data on cost increases because disclosure "might put Lockheed's position in the common stock market in jeopardy." Official records do not indicate, however, who in the Air Force bureaucracy ordered the cure notice or was responsible for deleting the cost data, but sworn testimony later would indicate that someone had decided to protect Lockheed. During an April 1969 Congressional hearing, Col. Kenneth N. Beckman, already selected to become director of the C–5A program in July when Colonel Townsend would receive promotion to brigadier general and become Deputy for Systems Management, confirmed under oath the omission of data on cost increases. An earlier memorandum, signed on October 9, 1968, by Trenton Boyd, the Air Force Deputy Auditor General, corroborated Colonel Beckman's statement.[44]

Though some of the management actions taken in early 1967 appeared puzzling, they formed a pattern. On one hand, the Air Force notified Lockheed that it would cancel its contract if performance did not improve; on the other, the Air Force seemed to go out of its way to safeguard the contractor's reputation which, should it be sufficiently tarnished, might actually threaten survival of both the program and the contractor. In other words, the Air Force wanted its new aircraft and, in order to get it, would willingly help Lockheed survive. Bernard D. Nossiter, a staff writer of *The Washington Post*, later would suggest that General McConnell, the Air Force Chief of Staff, had concealed from Secretary McNamara the magnitude of Lockheed's cost overruns. A memorandum for Secretary of Defense McNamara from Defense Comptroller Robert N. Anthony confirmed Nossiter's statement in a memorandum to Secretary of Defense McNamara. "You must be warned," Anthony had written on November 24, 1967, "that the McConnell memo of November 15 conveys incorrect information about the C–5A costs." In short, as Nossiter first reported on May 13, 1969,

General McConnell in November 1967 was telling Secretary McNamara that the cost of the total C–5A program remained below the Air Force estimate of March 1965, when it had in fact risen more than $400 million above that figure.[45]

When they concealed from Secretary McNamara the magnitude of Lockheed's cost overruns and technical difficulties, Air Force officers responsible probably did so out of fear that the Secretary of Defense might cancel the C–5A which, in their opinion, remained a national necessity. The cost overruns, technical problems, and actual concealment of such bad news became public knowledge in the spring of 1969. A. Ernest Fitzgerald, a civilian cost analyst and management systems deputy to Leonard Mark, the Air Force Assistant Secretary for Financial Management, testified about the C–5A before Congress, beginning in November 1968, and became, if not the most famous, at least the most revealing witness of the controversy over costs and concealment.

Fitzgerald served as a member of a special steering committee charged with tracking C–5A development. In this capacity, he attempted from the start to identify engineering problems that could account for the growing cost overrun. Fitzgerald caused trouble for the Air Force officers assigned to the project, like Col. Guy Townsend, the C–5A program director until mid-1969, who apparently believed that the civilian analyst had exceeded his authority and infringed on the responsibilities of the system project office.[46]

Meanwhile, on March 2, 1968, Lockheed-Georgia Company publicly displayed the first C–5A at Dobbins Air Force Base, near Atlanta. President Johnson delivered the principal address and emphasized that the new aircraft would revolutionize military air transportation by rapidly flying large numbers of troops and their battle equipment anywhere in the world. Following the President's address, Mrs. Harold Brown, wife of the Air Force Secretary, formally christened the C–5A with the nickname Galaxy. Within two years, even this seemingly innocent milestone would become controversial.[47]

The C–5A made its first flight on June 30, 1968, from Dobbins Air Force Base, Georgia, remaining aloft 94 minutes and apparently encountering no major problems. Four other C–5As took to the air within the next 12 months, and all reportedly performed well. For example, on June 15, 1969, the second C–5A landed at a record weight of 600,000 pounds, stopping within 1,500 feet. With a maximum takeoff weight (MTOW) of 762,000 pounds, aircraft number 2 also became the heaviest aircraft ever to leave the ground. On June 17, 1969, another C–5A, number 5, flew at a speed of Mach 0.8 at 35,000 feet and later reached an altitude of 40,200 feet. Other impressive milestones followed: the C–5A became the heaviest aircraft to refuel in flight, taking on 100,000 pounds of fuel from a KC–135 tanker; it attained a ramp weight of 768,158 pounds; and it carried 307,912 pounds of fuel with a simulated cargo of 197,640 pounds, landing within 1,200 feet. In addition, measured drag at cruising speeds proved two percent less than anticipated, signifying that the C–5A's range and payload might surpass expectations.[48]

Even as it boasted about the C–5's successes between 1967 and 1969, Air Force officials continued during the same period to minimize the aircraft's technical problems. For example, in mid-1968 the Aeronautical Systems Division noted that the C–5A's guidance subsystem, flight-tested for several months in a C–141A, did not meet specifications. The official records of ASD also indicated a need for design changes to eliminate malfunctions of the new aircraft's doppler radar, radar altimeter, and multi-mode radar. The division, however, reported no details on any of these important problems.[49] . . . . . .

After McNamara's departure from the Pentagon early in 1968, high-ranking Air Force officials remained concerned that the C–5A program might be canceled or reduced. The Air

Force leadership therefore continued to suppress information considered detrimental to the C–5A, a category that included measures the service had taken to penalize the contractor. For example, when Lockheed delivered five C–5As for flight testing, with various components that did not meet specifications, the Air Force withheld some $3.7 million from payments due to the contractor, but this punishment did not become known until 1970, and then only as the result of a General Accounting Office investigation prompted by accusations leveled against Lockheed by a former employee.[50]

During these difficult years, the engine program also exceeded its budget. The General Electric cost overruns proved minimal, however, compared with those of Lockheed. Perhaps for this reason engine development went practically unnoticed during the C–5A controversy. In any case, the Air Force scrupulously documented General Electric's problems, which were typical of the development of a large and complex turbofan like the TF39. In June 1968, after the number of test engines had increased, the program remained behind schedule. As the year 1968 ended, engine testing still lagged; only 8,000 of the planned 10,300 test hours had been completed. Some eight months later, however, testing of the TF39 mounted on one of SAC's B-52Es reached its conclusion. The program achieved its goal on August 29, 1969, when the engine accumulated the last of 258 hours of successful operation during 67 flights.[51]

Completion of the B-52E/TF39 testing program did not mean that all engine tests were over or that every engine problem was solved. The problems that remained did not seem especially serious, however. For example, in October 1969 the TF39 aft engine mount, located on the turbine's mid-frame, failed during a static test, but the failure did not affect on-going flight tests or the normal operation of the C–5As being delivered to the Military Airlift Command (MAC), as MATS had been redesignated in January 1966. Similarly, a labor strike at the General Electric plant in Evendale, Ohio, proved inconsequential. Colonel Beckman, the new director of the C–5A program, ordered immediate shipment to the Engine Buildup Unit of the Rohr Corporation's Winder Plant in Georgia of all heavy frame engines already accepted by the Air Force. The Evendale strike, which started on October 27, 1969, and lasted several months, could have been damaging, if Lockheed's deliveries of the transports had not already fallen behind schedule.[52]

In the meantime, the Air Force agonized over Lockheed's continued cost overruns. As indicated by the cure notice of March 1967, and the withholding of payments due Lockheed, the Air Force had not and would not overlook the aircraft's technical deficiencies or the contractor's recurring production slippage. In 1968, however, the most crucial problem remained cost, a problem aggravated by the contract's repricing formula and the formula's potential affect on the price of future C–5As. As the year drew to a close, attempts by the system project office at Wright-Patterson AFB, to reconcile Lockheed's cost estimates with those of the Air Force proved unsuccessful. The Air Force now had to choose between ordering additional aircraft from Production Run B without knowing the real cost of the first C–5As, or postponing further procurement—two equally unattractive alternatives.[53]

Playing Hard Ball

The terms of the total-package procurement contract signed in 1965 with the Lockheed-Georgia Company and the General Electric Company of Evendale, Ohio, provided for the purchase of additional aircraft and engines at predetermined prices. Specifically, the first purchase, the only one contracted for, involved 58 aircraft, including test versions, and 228 engines. The second purchase, referred to as Production Run B, numbered 57 aircraft and 279 engines; and the third, Production Run C, 85 aircraft and 429 engines. Production Runs

B and C. however, remained options that the Air Force had to exercise prior to January 1, 1969, or they would expire and the service would have to renegotiate the contracts.[54]

Because of the lucrative repricing formula in the original contract, Lockheed officials were especially eager for the Air Force to order at least the second production run. If the Air Force canceled Production Run B or ordered fewer aircraft than the number at which the repricing formula took effect, Lockheed could claim contract termination damages and could take its case to the Armed Services Board of Contract Appeals. The Air Force did not want to cut the program short and run the risk of litigation. It wanted its new transports and as many of them as possible.[55]

According to Ernest Fitzgerald, the Air Force Chief of Staff, General McConnell, became so outraged when he first learned of the repricing formula that his instinctive reaction had been to cancel the entire C–5A program, even if it meant hauling troops in "C–47 Gooney Birds." With the passage of time, however, McConnell's temper cooled, and he realized that C–5A program was too far along, and the aircraft too badly needed, to be abandoned. Just the same, the C–5A remained a vexing problem in late 1968, especially since money, as a result of the protracted war in Southeast Asia, was in short supply. Moreover, the Air Force was well aware of the war's growing unpopularity, public discontent with the military, and Congressional concern over the high cost of weapon systems.[56]

Taking Secretary McNamara's optimistic Congressional testimony of January 25, 1967, as the ideal, the outcome of the Air Force contract negotiations with Lockheed, going on in 1969, was unlikely to satisfy either the service or the contractor. Fitzgerald, who for years had a roving charter to examine programs and recommend ways of cutting costs, believed that the key to fiscal discipline lay in alerting either Secretary McNamara or Under Secretary of Defense Paul Nitze. Once he and his fellow analysts brought a problem to Nitze or McNamara, Fitzgerald said, "we could get a favorable ruling" for the recommended solution. McNamara and Nitze, however, were busy with a war and with other aspects of national security policy, and, as Fitzgerald pointed out, there was "no follow through" on their decisions.[57] For example, although McNamara had begun to learn the magnitude of the cost overruns in the C–5A program by the time he left office, he most likely remained unaware of the repricing formula.

On March 1, 1968, the day after McNamara's departure, Clark Clifford, a special counsel to President Truman from 1946 to 1950, became Secretary of Defense. He served less than a year, for the Republican administration of Richard M. Nixon assumed office in January 1969. Nixon chose Melvin R. Laird, a former Representative from Ohio, to head the Department of Defense.[58]

Apparently, Clark Clifford did not become deeply involved in the C–5A program until his term as Secretary of Defense was nearly over, but his contribution nevertheless proved significant. In January 1969, after months of frustrating negotiations with Lockheed, Secretary of the Air Force Harold Brown notified the company that the Air Force intended to go ahead with procurement of the Production Run B, an action that Secretary Clifford approved. Since the cost dilemma had not been resolved, Brown's letter of intent was possibly nothing more than an attempt to gain time and ensure that the deadline for exercising that option would be extended. Regardless of Brown's actual intent, Lockheed later claimed that the letter of intent formed a binding commitment.[59]

Meanwhile, in November 1968, Senator William Proxmire, a Wisconsin Democrat, personally informed Clifford of Congressional concern over the cost overruns in the C–5A program. Any new procurement of these aircraft, Proxmire declared, should await the results of an on-going investigation of the program by the General Accounting Office. Since he was

about to step down as Secretary of Defense, Clifford acted cautiously. He endorsed Secretary Brown's letter of intent but recommended that the new contract, Production Run B Supplemental Agreement number 235, limit the government's obligation to the purchase of only 23 aircraft. This restriction would reduce Production Runs A and B from 115 to 81 C–5As, enough to equip four squadrons with 16 aircraft each, but a total short of the 90 aircraft the government could procure before the repricing formula took effect. Lockheed may not have received official notice of Secretary Clifford's purpose, but the terms of the Air Force supplemental agreement for Production Run B made it quite clear that the firm could not take for granted the continuation of the C–5A program.[60]

Supplemental Agreement number 235 to the Lockheed contract obligated only $48.8 million for an initial increment of 23 additional C–5As programmed for fiscal 1970. In addition, the agreement reduced Lockheed's monthly production schedule from four aircraft to three. If the cost problem could be solved and all the aircraft of Production Run B actually procured, production would last until the end of June 1972. The Air Force believed that stretching out production would ease annual funding, which seemed necessary because money was scarce. According to Secretary Clifford, the stretch-out would also give the new administration more time to decide whether to fund the entire Production Run B. As written, Supplemental Agreement number 235 put Lockheed on notice that continuing failure would cost the firm money. If the program were terminated or canceled before the fiscal year 1970 funds were allocated, Lockheed would be entitled only to $30.5 million. Although an advance authorization for fiscal 1971 provided as much as $52 million, only $23 million was set aside to cover termination and cancellation during that year. Finally, similar clauses, but without specified monetary amounts, covered fiscal year 1972.

The supplemental agreement of early 1969 seemed to have resolved the issues of December 1968, but progress proved largely an illusion. In mid-1969, the Air Force tried once more to ascertain the extent of the contractor's cost overruns, to determine the re-pricing formula's potential impact, and to work out other problems including on-going production slippage. Lockheed, with an eye to future production, indicated that it wanted to purchase components and parts for all 57 aircraft of Production Run B with the $48 million specifically earmarked for procurement during fiscal 1970 of the 23 C–5A called for in the supplemental agreement. Since Lockheed's gambit would reduce Air Force leverage over the program. the service balked. The new crisis made little difference, however. for the C–5A program had become so notorious that higher authorities were exerting control of what had started as an Air Force.[61]

Catching the Public Eye

Despite Congressional authorization of an additional $624 million for the C–5A in fiscal 1969, criticism of the C–5A on Capitol Hill was growing. Senators William Proxmire, a Wisconsin Democrat, Stuart Symington, a Democrat from Missouri and the first Secretary of the independent Air Force, and Richard Schweiker, a Pennsylvania Republican, as well as Representatives William Moorhead, a Pennsylvania Democrat, and Martha W. Griffiths, a Democrat from Michigan, led the complaints about the rising cost of the new transport. Ernest Fitzgerald not only ignited the fires of opposition with his initial testimony on November 13, 1968, he fanned the flames in three subsequent appearances before the Joint Economic Subcommittee headed by Senator Proxmire, and before other Congressional panels. Considerations other than Fitzgerald's charges exacerbated the controversy over the C–5A's technical shortcomings, Lockheed's cost overruns, and Air Force's concealment of relevant

information. These factors included the hardening of public and Congressional attitudes toward military spending—a trend given impetus by the long and costly Vietnam conflict—and the media's relentless coverage of the program's difficulties.[62]

When first testifying in November 1968, Fitzgerald somewhat reluctantly confirmed Senator Proxmire's assumption that the Production Runs A and B, the purchase of 115 C–5As and their spare parts, would cost about $5.2 billion, almost $2 billion more than estimated by the Air Force in 1965. Actually, the program's cost overruns, which triggered Senator Proximire's initial inquiries, no longer remained the only issue. A question arose in the spring and summer of 1969 whether the Air Force concealed facts, failed to disclose information needed by the Congress, and manipulated records. Amid the charges of duplicity, Air Force justifications of C–5A cost increases proved inconsistent at best. In 1969, the Air Force claimed that the original cost estimate pertained to a smaller C–5A, did not include spare parts, had not taken into account for the immediate higher labor cost caused by the competing demands of the Vietnam conflict. Fitzgerald not only denounced these claims but also stated that the Air Force falsely denied knowledge of the warnings that he and others had submitted on the C–5A's mounting expenses. He cited in particular a memorandum written as early as December 1966 in which Col. Larry M. Killpack, a member of the Directorate of Production and Programming on the Air Staff, informed General Goldsworthy of numerous cost overruns and concluded: "my quick analysis of the situation is that Lockheed is in serious difficulty on the C–5A."

In testimony during June 1969, Fitzgerald suggested that pressure from elected representatives might have influenced the Air Force to increase the order for C–5As. Although he did not identify any of these elected officials, the next day, the next day's newspapers gave front-page coverage to Fitzgerald's statement, pointing out that the main assembly plant for the C–5A was located at Marietta, Georgia, in the home state of Democratic Senator Richard B. Russell, Chairman of the Senate Armed Services Committee. The soaring costs of military hardware had been investigated before, but the injection of politics and the brandishing of the name of a Senator as powerful as Russell enlivened the C–5A controversy, capturing the attention of the media and through them reaching the general public.

Meanwhile, as a result of Fitzgerald's November 1968 testimony, Congress early in 1969 interrogated others deeply involved with the C–5A. Those who testified included Colonel Beckman, due to become the C–5A's new program director in July 1969. When questioned on April 29, 1969, by Representative Moorhead of the House Government Operations Committee, Beckman confirmed that management reports within the Pentagon had been altered to conceal cost overruns and protect Lockheed's position on the New York Stock Exchange. Following Colonel Beckman's testimony, Senator Proxmire in May 1969 asked the Securities and Exchange Commission (SEC) to investigate whether there had been any violation of securities law in the C–5A procurement.[63]

The Air Force, meanwhile, relieved Fitzgerald of his most important duties, isolating him from oversight of major weapon systems—a decision attributed to Assistant Secretary Charles and apparently anticipated and condoned by Secretary Brown prior to his departure early in 1969. By the time of this Air Force action, *The Washington Post*'s extensive publicity of Fitzgerald's first testimony had already jeopardized the cost analyst's future. On November 25, 1968, the Air Force personnel office had revoked Fitzgerald's career status on the grounds of a "computer error." Career status, which afforded some protection against arbitrary firing, required three years of uninterrupted federal service but somehow the computer that credited him with at least this much service had erred, or so the Air Force said.[64]

The testimony of Fitzgerald and other witnesses prompted Senator Proximire to ask Robert Charles, the Assistant Secretary of the Air Force for Installations and Logistics who had relieved Fitzgerald of meaningful duties, to give his version of Lockheed's problems and the Air Force's documentation of them. Charles did not deny that he had personally or indirectly arranged the deletion of references to technical problems, schedule slippage, and cost overruns. He insisted, however, the deleted information had actually been nothing more than preliminary estimates, requiring actual proof later on. By way of proof, he pointed out that the C–5A's technical performance exceeded both Lockheed's proposed performance and the firm's contractual commitments. Charles thus concluded that the C–5A purchase was, "the best contract ever entered into by the Air Force."

When asked if Lockheed could have purposefully underbid its competitors on the belief that it could recoup its losses through later design changes, Charles did not deny such a possibility. Total-package procurement sought to halt this practice, he said, but Lockheed "may have believed that we wouldn't hold them to the contract. And there would be some merit in such belief; after all, we hadn't in the past." When it came to the much criticized repricing formula, Mr. Charles explained that it had been designed only to prevent "catastrophic losses" by the company. In any case, he reiterated, the Air Force had the option of canceling the contract "in whole, or from time to time, in part," by written notification.[65]

Charles resigned on May 5, 1969, a few days after his last testimony. His departure was accompanied by that of Thomas H. Nielsen, who in January 1968 had replaced Leonard Marks as Assistant Secretary of the Air Force for Financial Management. Charles's replacement as Assistant Secretary of the Air Force for Installations and Logistics was Phillip N. Whittaker who, like Robert Seamans, President Nixon's new Secretary of the Air Force, came from the National Aeronautics and Space Administration (NASA), where he had served as an assistant administrator. Personnel changes were not unusual in the first months of a new administration, but on May 1, when announcing the new appointments, Secretary of Defense Laird had directly linked the departures of Charles and Nielsen to the woes of the C–5A program. Laird announced that he fully intended to straighten out the financial tangle that had ensnared the C–5A—a task that would prove surprisingly difficult.[66] . . . . . .

As a first step toward solution of the C–5A problem, Laird immediately directed Secretary of the Air Force Seamans to review the C–5A Program. This evaluation, conducted by the new Assistant Secretary of the Air Force for Installations and Logistics, became known as the Whittaker Report. Released to the press in late July 1969, it concentrated on procurement and contracting transactions between 1965 and 1969, before the Nixon administration had taken office. The report mentioned problems with the integration of subsystems, subsystem reliability, and structural fatigue. It further stated, however, that: "An extensive evaluation by Air Force and NASA experts has revealed no major design deficiencies in the [Lockheed] aircraft or [General Electric] engines, and there is a high probability that all range, payload, takeoff and landing performance requirements will be met." Even so, Whittaker and his colleagues conceded that Lockheed's description of the C–5A's performance outlook seemed overly optimistic.[67]

The year 1969 brought other disturbing news for the Air Force and the C–5A. Although the investigation by the General Accounting Office bogged down because Lockheed refused to make available cost data requested by the Air Force on behalf of Proxmire's subcommittee, the manufacturer remained in trouble. At the Marietta, Georgia, plant engineers struggled to solve stubborn technical problems. In addition, financial problems While Lockheed faced these difficulties, rumors circulated that Fitzgerald had been leaking classified information to Congress. Secretary Seamans, the suspected source of the rumors, quickly and

unequivocally denied their validity, but Fitzgerald was not appeased. He kept insisting publicly that his efforts to reduce inefficiency and waste had been frustrated by both the Air Force and Lockheed. Finally, in November 1969, Spencer J. Schedler, Nielsen's successor as Assistant Secretary of the Air Force for Financial Management, engineered a reorganization of his office that eliminated Fitzgerald's position and, since he had been deprived of the protection of civil service status, left him without a job. The Civil Service Commission would subsequently rule in September 1973 that Fitzgerald had been improperly fired and had to be restored to duty and receive the pay he had lost. He returned to work for the Air Force on December 10, 1973, as a deputy for productivity management, but he had no real authority and only trifling responsibilities. In 1974, his attorneys filed several lawsuits on his behalf, one of which claimed that the Air Force had arbitrarily demoted him after his reinstatement. Another was a personal damage suit against those who had conspired in his illegal firing. In 1982, after years of litigation that almost reached the Supreme Court, the lawsuits ended in a settlement. The Air Force paid $200,000 to defray part of his legal expenses and agreed to give him a job truly comparable to the one he had originally held.[68]

Nevertheless, 1969 was not entirely bad for the Air Force and its C–5A. Perhaps because of the Whittaker Report's encouraging appraisal, the Senate voted 64 to 23 against an amendment offered by Senator Proxmire to strip from the fiscal 1970 military procurement bill $533 million earmarked for the aircraft. Prior to the vote, Senator Symington spoke forcefully in favor of buying additional C–5As. Despite the steep escalation in costs, Symington argued, spending the money for the huge aircraft was consistent with the effort to cut the military budget and reduce American commitments overseas. "It may be a poor buy," Senator Symington observed, "but what is bought is essential for our national security."[69]

The defeat of the Proxmire amendment ended a turbulent moment in the C–5A program. The conduct of the governmental parties involved in the program's development—a combination of consistently good intentions and often devious means—would be vindicated beginning in August 1970, when carefully selected C–5As started flying strategic airlift missions, albeit under stringent weight restrictions, in support of American combat operations in Southeast Asia. Yet, as the new Republican administration set about solving the C–5A's financial difficulties, it faced a multitude of costly and difficult that would require new wings for the airplane.

Considering the many C–5A problems in the late 1960s, it is difficult to understand why the Air Force or the Department of Defense did not cancel the new transport. Had they done so, however, they would have spent $1.7 billion for a maximum of six incomplete and structurally deficient transports. Even more unbelievable at that point was the notion that in July 1985—20 years after the C–5A program began—the C–5B, a second version of the transport, would take to the air. In the interim, the C–5A created a history of its own.

Endnotes

1. Nelson, "Kennedy's Policy," pp 1-12; Trewhitt, *McNamara's Ordeal*, p. 168.
2. Nelson, "Kennedy's Policy," pp. 1-12; *Annual Report of the Secretary of Defense*, Fiscal 1966, pp. 3-12.
3. Nelson, "Kennedy's Policy," pp 1-12.
4. David Alan Rosenberg, "The History of World War II, 1945-1990: A Conceptual Framework," in *Essays in International History, On Cultural Grounds* (Chicago: Imprint Publications, 1994) pp. 211-212; Trewhitt, *McNamara's Ordeal*, p. 125.
5. Jane E. Stomseth, *The Origins of Flexible Response*: *NATO's Debate over Strategy in the Sixties* (New York: St. Martin's, 1988). p. 16.
6. Rosenberg, "The History of World War II, 1945-1990," pp. 211-12.
7. Stromseth, *Origins of Flexible Response*, p. 3.
8. . *Ibid*., pp. 3-4, 181-82.
9. Trewhitt, *McNamara's Ordeal*, pp. 168, 178.
10. *Anything, Anywhere, Anytime*, pp. 154-57; Francillon, "Galaxy," p. 273; Stromseth, *The Origins of Flexible Response*, pp. 3, 176, 181; *The Columbia History of the World*, p. 1080; Trewhitt, *McNamara's Ordeal*, pp. 168-80; *Annual Report of the Secretary of Defense*, Fiscal 1966, pp. 252-53.
11. Ltr, Gen Schriever, AFSC Commander, to Lt Gen Ferguson, Hq USAF (AFRDC), subj; Systems Command Position, CX-HLS Program, Sup. Doc. 35 to Levy, *C–5A, 1961-1965*.
12. *Ideas and Concepts*, pp. 311-312; Memo, Theodore von Kármán, Director, Army Air Forces Scientific Advisory Board, to Gen H. H. Arnold, Commanding General, Army Air Forces, December 15, 1945.
13. *Annual Report of the Secretary of Defense*, Fiscal 1962, pp. 6-7; *Anything, Anywhere Anytime*, pp. 103-104.
14. Levy, *C–5A, 1961-1965*, p. 95.
15. *Ibid*., pp. 99-100, 103; Watson, *History of the Office of Secretary of the Air Force*, chapter 9.
16. Levy, *C–5A, 1961-1965*, p. 104; Office of Secretary of Defense News Release 510-65, August 5, 1965.
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CHAPTER IV

SETTLEMENT OF THE C–5A PROGRAM AND ANOTHER PROCUREMENT REFORM

President John F. Kennedy, in his first defense message to Congress in March 1961, announced the buildup of the airlift forces to support flexible response, a new national policy to counter the Soviet ability to attack the territory of the United States and its allies.[1] President Kennedy also endorsed immediate development of the CX-HLS (Heavy Logistics System) that became the Lockheed-Georgia C–5A strategic transport, the only truly gigantic airplane of this type under consideration in the early 1960s. Some two decades later, despite charges of fraud and deception, scandals of every kind, various aerodynamic and structural problems, and shocking cost increases, an improved model, the C–5B, took its place alongside the original plane, by now radically modified.

Developing transports to haul heavy cargo in support of flexible response cost vast sums, even though Robert Charles, a former executive of the McDonnell Aircraft Corporation now serving as an Assistant Secretary of the Air Force for Installations and Logistics, championed the total-package procurement concept (TPPC), designed to control expenditures and satisfy Secretary of Defense McNamara's insistence on cost-effectiveness. TPPC seemed simple, but was never carried out in detail, did more harm than good, and damaged the reputation of the Air Force.

In October 1965 the Air Force chose the C–5A over a cargo craft proposed by Boeing that the leaders of several major commands and other high ranking military officials preferred. Lower cost gave Lockheed a decisive edge, but the C–5A strategic transport afforded some remarkable features (See Appendix 1), including the quick and efficient loading of such bulky equipment as two main battle tanks or 24 attack helicopters. A kneeling landing gear lowered the cargo deck to truck-bed height for loading from the front or rear, something that only the C–5A could do.[2] Offsetting these advantages, the aircraft's wing succumbed to metal fatigue in as few as 7,500 flying hours, one fourth of the projected useful life. After January 20, 1969, when President Richard M. Nixon assumed office, the Air Force continued to reduce the payload, while attempting to fix the wings, but this proved as futile as trying to mend a broken leg with band aids.[3]

The Nixon administration's Department of Defense did not underestimate the magnitude of the problems left unsolved by the Johnson administration and still troubling the C–5A program. Secretary of Defense Melvin Laird, especially, worried about the likely repercussions of the C–5A controversy on other military projects at a time of extreme discontent with the Vietnam War and the rising cost of weapons procurement. Laird expected that deficiencies in aircraft subsystems and in the airframe itself, along with the probable results of on-going investigations by the Securities and Exchange Commission and the General Accounting Office, would fuel the dispute involving Lockheed and the defense establishment.

Because the Air Force needed the C–5A, the most urgent and overriding consideration was to ensure continued production. Ideally, the Air Force would resolve swiftly the dispute with Lockheed, but an ideal solution seemed improbable. Moreover, irreconcilable differences over the program's cost overruns and the aircraft's engineering problems seemed likely to persist. The coming years, 1970 especially, promised more turmoil.

Money, A Continuous First Priority

The cost estimates worked out by the Air Force and endorsed by Secretary McNamara in February 1965 were generous—between $3.2 and $3.4 billion for 115 C–5As, including five test aircraft later to be brought up to operational standard. Actually, the government's maximum estimate of $3.4 billion was double the amount of the low-cost bid for the same number of aircraft, which had earned Lockheed its contract. In the context of total-package procurement, all these estimates covered the cost of spare parts and made allowance for inflation. Even so, the $3.4-billion maximum estimate of 1965 failed the test of time. Testifying under oath, a civilian cost analyst employed by the Air Force, A. Ernest Fitzgerald, in November 1968 predicted a total price to $5.2 billion, a staggering cost overrun of $1.8 billion. The difference among Lockheed's initial estimate, that of the Air Force, and the projection by Fitzgerald cried out for an explanation.

On May 2, 1969, a few days before his resignation, Assistant Secretary Charles still denied the validity of Fitzgerald's estimate of a $1.8-billion overrun and insisted that the actual amount would be a mere $382 million. Charles's explanations apparently reflected a 1964 Air Force cost estimate of $3.1 billion for 120 aircraft. He did not mention the number of aircraft involved, however, and the net result of his lower estimate was to trigger counter-claims that raised Fitzgerald's $1.8 billion to $2.1 billion. Seemingly unperturbed with this result, Charles justified his $382 million cost increase by subtracting from the $2.1 billion overrun the costs of spare parts ($855 million) and design changes ($350 million), along with $500 million to compensate for inflation—three potential sources of cost increase that total-package procurement was designed to prevent. The explanations offered by Charles lacked credibility, since the repricing formula, which undercut total-package procurement, had already come to light.

Charles had apparently refused from the start to implement whole-heartedly the total-package method of procurement which he had personally championed. On May 14, 1969, shortly after Charles departed. Robert Seamans, the new Air Force Secretary, announced that the first two production runs of C–5As, 115 aircraft and spare parts, would indeed cost $5.2 billion, the amount cited in the Fitzgerald's testimony. Like Charles, Seamans insisted that the $3.4 billion Air Force estimate of 1965 had neither included spare parts, estimated at $840 million, nor provided for inflation, some $500 million, nor earmarked $350 million to cover the cost of engineering modifications. The increases listed by Seamans mirrored those Charles identified, and both stemmed from sources that total-package procurement was supposed to eliminate. The new Secretary of the Air Force also insisted that the $3.1-billion estimate cited by Charles pertained to a smaller version of the aircraft which the Air Force chose not to order. Actually, the cost increases itemized by Seamans were similar enough to those identified by Charles to indicate that the new Secretary and the former Assistant Secretary had closely monitored closely the C–5A financial data.

Reconciling the divergent Air Force versions of events set forth by Charles and Seamans appeared futile. Moreover, the war in Southeast Asia, which beset the Johnson Administration, continued under Nixon and clearly required the services of the C–5A. These circumstances may well have explained Secretary of Defense Laird's decision to stop discussing the cost overruns. Hence, a few months after his appointment, Secretary of Defense Laird in June 1969 took issue with Seamans's acknowledgment of a $2 billion overrun, declaring that a preliminary analysis by the General Accounting Office indicated that the increase in contract cost was only about $500 million.[4]

In September 1969 the Senate voted to reject the Proxmire amendment and continue

the C–5A program, and immediately afterward Secretary Laird endorsed the Air Force's final decision of June 1969 to cut the program from 115 aircraft to a total of 81. This did not end the arguments over funding, because the program's eventual cost remained unknown. The C–5A Program Office had unsuccessfully attempted throughout 1968 to ascertain the extent of Lockheed's cost overruns, but uncertainty over the true costs persisted. The Air Force knew how much money Congress had appropriated since the program's inception,[5] and it knew how much had been expended thus far, but it could not identify Lockheed's financial status relating to the C–5A. Moreover, the contractor's defensive behavior throughout 1969 and the first six months of 1970 did nothing to clarify the financial picture.[5]

The Unsolved Financial Dilemma

In mid-1969, after the Air Force indicated it would purchase only 23 of the 57 aircraft in Production Run B, the buyer and seller were practically at each other throats. Lockheed officials contended that the January 1969 Supplemental Agreement 235 to the original Lockheed contract, which limited the government's obligation to a "first" additional purchase of just 23 Run B aircraft, was not valid. The contractor also insisted that the letter of intent signed by Secretary of the Air Force Brown prior to his departure was binding and committed the Air Force to buy all 57 C–5As of Production Run B. In contrast, Lt. Gen. Duward Crow, Comptroller of the Air Force, argued that the Air Force had committed itself only to "the right to buy the planes"; and Robert Moot, the new Comptroller of the Department of Defense, stated that the order for more than the 23 planes depended specifically on the authorization of funds for them by Congress. However, Thomas R. May, now President of the Lockheed-Georgia Company, told the Senate Armed Services Committee in July 1969 that as of May 30, 1969, Lockheed had spent almost $1.57 billion on the 58 C–5As of Production Run A, for which the government had paid only $1.52 billion.

Since only a handful of C–5As had been completed by mid-1969, the Air Force seemed the sure loser in the struggle over the C–5A. Bluntly put, albeit delicately phrased at the time, in the event Lockheed decided to cancel the contract and stop production, the terms of the agreement would compel the service to pay over $1.5 billion for less than a dozen aircraft.[6]

In the spring of 1969, Lockheed's threat to take its case to the Armed Services Board of Contract Appeals troubled Air Force leaders. As time went by, the situation grew even more serious. Besides obligating $48 million to Lockheed for production increments in fiscal years 1970 through 1972, Supplemental Agreement 235 contained an advanced-buy authorization for fiscal 1970 not to exceed $52 million. If the government failed to fund these fiscal year production increments before November 30, 1969, Lockheed, in accordance with the contract's termination and cancellation clause, would be entitled to $30.5 million. In the event of cancellation, commitments for all or part of Production Run B, such as the 23 aircraft identified by the supplemental agreement, would become void and contract options between Lockheed and its subcontractors would lapse. Furthermore, Lockheed would probably be unable to continue Production Run A and would have to lay off 20,000 employees. Lockheed's subcontractors and vendors, in turn, would also dismiss a significant number of their workers. Finally, according to the Aeronautical Systems Division (ASD) of the Air Force Systems Command (AFSC), even a lesser delay by a Congress in appropriating the necessary

[5] See Appendix 2.

funds, a highly conceivable result of a $400 or $550 million increase in the price of Run B.[7]

The Air Force, although exasperated by the growing problems with the C–5A, seemed to understand Lockheed's difficulties. Instead of requesting termination, the Air Force noted that Lockheed could request an adjustment in price and delivery if it incurred additional costs or a delay in production. Such a solution could serve the same purpose as the contract's repricing formula, perhaps without arousing further controversy. Other indications arose that the Air Force was determined to find a conciliatory solution that would satisfy both Lockheed and the service and, above all, serve the nation's best interests. For example, a section of the July 1969 Whittaker Report, prepared by Air Force and NASA experts, which the press had either not received, overlooked, or ignored, addressed the cost of inflation, endorsing conclusions reached by the Aeronautical Systems Division and casting a more favorable light on Lockheed and on the $2.2 billion cost overrun.[8]

Back in May 1969, Phillip N. Whittaker, the recently appointed Assistant Secretary of the Air Force for Installations and Logistics, had reconvened an ASD cost survey team which, in anticipation of Supplemental Agreement 235, attempted a thorough review of the C–5A's financial status. The team's updated findings, presented on July 3, 1969, to Maj. Gen. Harry E. Goldsworthy, the new commander of the Aeronautical Systems Division, became the basis of the cost evaluation included in the Whittaker Report.

The ASD team's conclusions included a prediction that Lockheed's production costs would increase further and raise the price of the aircraft to the government. The team attributed the increase to three factors: an inflationary trend in the American economy; extension of the aircraft delivery schedule over a longer period; and reduction in the monthly aircraft production rate from four to three, the last two a result of Supplemental Agreement 235.

The ASD team's report did not whitewash Lockheed contribution to the overruns, noting that "it is impossible to differentiate between the effect of inflation on the increased costs and the effect of optimistic contractor estimates and/or contractor efficiency." The suggested causes had already been noted, Charles himself admitting that Lockheed could have underbid purposely in order to secure the C–5A contract. As for the contractor's efficiency, the cure notice issued in 1967 clearly reflected the Air Force Systems Command's low opinion of Lockheed's early efforts.

The ASD report also raised two other extremely important points. First, materiel and manufacturing efforts accounted for "the major portion [of the cost overruns]." This had been anticipated by General Schriever, AFSC's former commander, now retired, who all along believed the contractor would have to use exotic and expensive new materials to satisfy the future transport's ambitious technical performance requirements. As Air Force headquarters was beginning to find out, Schriever's early misgivings over the technical risks of Lockheed's C–5A design had been well founded. Second, the report revealed that the Air Force had raised the cost of future C–5As, including those aircraft of Production Run A not yet built, because of soaring inflation rates. The increase, which the Air Force considered fair, might not be enough to satisfy Lockheed.[9]

Cutting Losses

The Nixon administration's decision to decrease the total C–5A procurement from 115 to 81 was the very outcome that Lockheed had been fighting since January 1969, when the original C–5 contract was modified by Air Force Supplemental Agreement 235. Change Order 521, which embodied the decision, was a unilateral Air Force document, prepared by ASD, revised by the Air Force Systems Command as well as the Air Staff, and issued by Air Force

Secretary Seamans on November 25, 1969. The fourth paragraph of Change Order 521 stated specifically that:

> The government reserves all rights to challenge as unauthorized any expenditures made or costs incurred on Production Run B other than on the Fiscal Year 1970 increment of 23 (twenty-three) aircraft and associated equipment. The government does not by this paragraph relinquish any or all other rights it may have under this contract or otherwise to challenge any or all costs incurred or expenditures made under any portion of this contract.[10]

Predictably, Lockheed-Georgia reacted to Change Order 521 as it had to Supplemental Agreement 235. Its attorneys argued, as they had before, that the basic agreement committed the government to purchase all 57 Aircraft of Production Run B; therefore Change Order 525 amounted to an arbitrary and illegal revision of the contract. The government's apparent intransigence, said the Lockheed attorneys, represented an illegal use of duress, forcing the contractor to accept a cut in production. While the attorneys argued, Lockheed notified its subcontractors to stop work and informed them of a partial termination, which would require Lockheed and its subcontractors to negotiate repricing agreements and termination allowances on the basis of twenty-three aircraft actions that could only raise the aircraft's ultimate cost.

After further negotiation with the contractor, the Air Force, in accordance with established procurement procedures, found itself compelled to forward on February 18, 1970, Lockheed's formal appeal to the Armed Services Board of Contract Appeals. The Air Force had tried to avoid this development, and for good reason, since Lockheed had suffered genuine losses that might impress a review panel. An ASD concurrent cost study, predicated on a total production of 81 C–5As (58 aircraft in Production Run A and 23 in Run B), revealed that Lockheed, after spending in excess of $3.1 billion, could expect a probable reimbursement of less than $2.6 billion, leaving the contractor with a loss of nearly $650 million. General Electric stood to lose $2 million after spending $778 million to develop and manufacture an engine for the transport. Lockheed's own errors no doubt contributed to its loss, but the Armed Services Board of Contract Appeals, the normal mechanism for litigating disputes of this sort, might find it difficult to apportion blame between contractor and the Air Force.

In the meantime, indications appeared that Lockheed's financial position might be more precarious than the company's attorneys wished to admit. In February 1970, the same month Lockheed's case reached the Board of Contract Appeals, the President of the Lockheed-Georgia Company, Thomas R. May, disclosed at a press conference that his firm had proposed a new delivery schedule that reduced monthly production from three aircraft to two, thus increasing the cost still further, and postponed completion of the 81 C–5As from June 1972 until February 1973. This change was necessary, May claimed, for a number of reasons. It provided the 22-month lead-time needed between receipt of the order and delivery of the finished aircraft, and forestalled the need to suspend operations for perhaps two years. May indicated that stretching out the program, instead of halting production, was essential because of possible future C–5A orders from the Air Force or foreign governments, and because of potential orders for the proposed L-500, Lockheed's hoped-for commercial derivative of the huge transport.

A month later, on March 2, 1970, Daniel J. Haughton, Chairman of the Board of the Lockheed Aircraft Corporation, in a letter to Deputy Secretary of Defense David J. Packard,

acknowledged Lockheed's worsening financial plight. Work on all of Lockheed's defense contracts would cease unless the company received between $600 and $700 million, most of it for the C–5A program. Lockheed, Haughton declared, could not wait for the board of contract appeals to "establish final amounts due the company from the Defense Department." Moreover, the company would require interim financing before the end of December 1970 to maintain "uninterrupted performance" of the C–5A contract. Bills for subcontracting, labor, and materials fell due periodically; and Lockheed could not assume the "financial burden while awaiting the outcome of [years] of litigation resulting largely from drastic innovations in procurement procedures utilized by the military services."

Although Haughton, the Lockheed chairman, conceded in his letter some "deficiencies" on Lockheed's part, he insisted that total-package procurement caused the company's woes. Adopting the untried technique, he said, was "imprudent and adverse to our respective interests"; the concept had proved "virtually unworkable." Nor did he see much interest on the part of the Air Force in correcting existing contracts on terms acceptable to the contractors, or any attempt "to recognize that litigation is a seriously inadequate avenue."

With Lockheed apparently backing away from litigation, the Assistant Secretary of the Air Force for Installations and Logistics, Phillip Whittaker, promptly created a contract negotiating committee headed by Maj. Gen. Edmund O'Connor, ASD's vice-commander. Working with Lockheed representatives, the new ASD committee drew up a proposed memorandum of agreement as the basis for a new C–5A contract. This document reached Deputy Secretary of Defense Packard and Chairman Haughton in May 1970, only two months after Packard received Haughton's letter. Another year would pass, however, before the two parties, each jockeying to get the most favorable settlement, would reach a final agreement. During these twelve months, unusual financial transactions had to be worked out as the Air Force once again confronted serious problems with the C–5A, though a few positive developments had surfaced.[11]

On the positive side, the Securities and Exchange Commission's investigation, initiated in May 1969, reported in mid-1970 that no Air Force or Department of Defense personnel, military or civilian, had benefitted from the alleged cover-up of Lockheed's technical and financial difficulties. Some of Lockheed's managers did not fare so well. The SEC report contained no evidence of illegal trading, but it did disclose that a number of Lockheed executives had sold their company stocks at the top of the market, in late 1965 when Lockheed's future seemed assured and in 1966 and 1967 before the Air Force presented the company with a cure notice. At this time, the company's stock fluctuated between $60 and $70 a share. Thanks in part to extensive media coverage of the C–5A controversy, the price of a share declined to $30.00 in 1969 and plummeted below $10.00 in 1970.[12]

Another event, eagerly awaited by the Air Force, occurred in September 1970, as the first squadron in the Military Airlift Command (MAC) attained initial operational capability (IOC) at Charleston Air Force Base (AFB), South Carolina. The IOC lagged more than a year behind the original schedule, and several months beyond a revised date established on December 17, 1969, when MAC took delivery of its first C–5A. In the next six months, MAC's transport training unit, the 443rd Military Airlift Wing at Altus AFB, Oklahoma, received its allocated complement of aircraft—initially eight but later reduced to six and then four—and three of the eight C–5As earmarked for Charleston AFB, South Carolina, arrived there in June 1970. The buildup at Altus and Charleston slowed because of MAC's decision to reserve five aircraft for its own use. The operational C–5As at Charleston, moreover, experienced considerable difficulty with their landing gear, forcing postponement of the squadron's IOC until September.[13]

Despite the delay and the problems encountered with some of the C–5As that reached the operational inventory, MAC's September 1970 IOC was encouraging. Although the contractor's financial status kept getting worse, this decline had been expected, and the memorandum of agreement worked out by General O'Connor's committee provided options to take care of Lockheed's most urgent difficulties. One option would "increase the percentage of the ceiling which could be paid out in progress payments from 90 to 95 percent, without increasing the progress-payment rate," which remained once a week. Another would add $200 million for the known effects of the repricing formula contained in the contract, in advance of the actual time when such funding might need to be applied "under the strict terms of the contract."[14]

As a start, the appropriations for fiscal 1970 provided an extra $225 million to cover amounts in excess of the target cost for Production Run A; in addition, Lockheed was authorized to receive $34 million for research and development and $481 million for production. On June 11, 1970, the Senate Armed Services Committee earmarked $200 million in contingency funds to meet Lockheed's weekly progress payments. The money, however, was not easily obtained. Still angry about the spiraling costs, Senator William Proxmire pointed out that the General Accounting Office's investigators had been unable to find out how Lockheed had spent the money already received for the C–5A program. Proxmire tried to prevent the Senate Armed Services Committee from approving any contingency funding before Lockheed had fully disclosed its cash position. Just a few weeks before the vote on the fate of contingency funding, the Wisconsin senator began arguing that Lockheed's financial crisis "has been caused by its commercial venture, the L-1011 aircraft, and not by its government contracts."[15]

Senator Proxmire was not alone in his opposition to making more money available to Lockheed. Colleagues in the Senate as well members of the House objected to what Proxmire described as the government's "bail out" of Lockheed, but the C–5A program counted many Congressmen as staunch supporters, notably South Carolina's Mendel Rivers, Chairman of the House Armed Services Committee, in whose district the Charleston-based C–5As would operate. Not once during the controversy, had Rivers's determination wavered. Halting the C–5A program would be like "cutting our nose to spite our face," the chairman declared in June 1969, adding soon afterwards "regardless of what this plane costs, we need it, and we must have it." In June 1970, many politicians, including President Nixon's Secretary of the Treasury, John Connally, shared Rivers's opinion. Consequently, the House by a vote of 90 to 48 rejected an amendment, introduced by Otis Pike, a Democrat from New York, to eliminate the extra $200 million. The Senate defeated a similar amendment, presented by Richard Schweiker, a Pennsylvania Democrat, 48 to 30. Even though the vote was closer in the Senate, the program seemed safe for the time being, as much because of the jobs lost if Lockheed should fail as in recognition of the company's past contributions to American military and civil aviation.[16]

Defeat of the Pike and Schweiker amendments accelerated Air Force efforts to sustain the C–5A program, making sure it was truly saved rather than merely granted a stay of execution. Commercial banks and airlines, which had already lent Lockheed about $450 million, agreed in September 1970 to lend Lockheed another $250 million if it could reach a favorable settlement of the C–5A dispute with the government. Lockheed needed the additional loan to proceed with production of its L–1011 Tristar jetliner. Because of a sharp decline in the commercial aviation business, the California-based corporation had received only a hundred or so firm orders for the L–1011—fewer than half the number needed to cover production costs.[17]

On December 30, 1970, Deputy Secretary of Defense Packard outlined for Senator John C. Stennis, a Democrat from Mississippi and Chairman of the Senate Armed Services Committee, the critical aspects of the current situation. Prolonged litigation, said Packard, would leave Lockheed with "insufficient cash and inadequate commercial credit to finance the continued operation of vital defense programs." Moreover, the company needed additional government funding and bank support to forestall bankruptcy, and Lockheed's failure, because of the intricate relationship among Lockheed and other defense contractors and suppliers, could set off a disastrous chain reaction in the American aerospace industry.

Packard also told Stennis that the disputed costs amounted to $758 million, and that there were two ways to settle the C–5A dispute: either fund the contractor fully, with litigation determining whether the Air Force ordered 81 or 115 aircraft and what effect the repricing formula would have on the final cost to the government; or persuading Lockheed to abandon legal proceedings in return for funding the amount at issue except for $200 million, a loss that Lockheed would have to absorb. Whichever alternative might prevail, the Air Force would have to exert "a more active role" in program management, and "provide all the funds to complete the C–5A program." Packard, however, preferred the second alternative because it offered a prompt and permanent solution.[18]

The immediate solution favored by the Defense Department did not please the Lockheed Corporation, and Daniel Haughton wasted no time in reiterating the soundness of the corporation's legal position. In a letter of January 5, 1971, Lockheed's chairman protested Packard's trying to resolve the C–5A dispute by forcing the company to lose $200 million, an "excessive and unwarranted penalty," according to Haughton. Lockheed would therefore proceed with litigation.

Real or feigned, Haughton's indignation could not endure. Faced with dwindling production funds for the C–5A, he agreed on February 1, 1971, to accept the $200 million fixed-loss settlement. As a result, Lockheed forfeited $100 million already spent but due to be recouped under the terms of total-package procurement. Repayment of the balance would begin in January 1974 with annual payments of $10 million or ten percent of profits, whichever was greater.

On May 6, 1971, Secretary of the Treasury Connally announced that President Nixon would ask Congress to provide a $250 million loan guarantee to ward off Lockheed's potential bankruptcy, and a bill to that effect was introduced on May 13. Although worded to cover "major businesses in danger of failure," the loan guarantee focused on saving Lockheed, which would receive most of the money. General Electric was not forgotten, however. On September 15, after months of intensive negotiation to forestall possible litigation and eliminate administrative problems, the engine manufacturer signed a new contract restructured by the government on the pattern subsequently adapted to the Lockheed airframe contract.[6] The new agreement reduced the original 279 engines for Production Run B to a maximum of 176, reflecting the procurement of just 23 aircraft.[19]

Effective May 31, 1971, Supplemental Agreement 1000 replaced the C–5A contract of October 1965, as amended over the years, and marked the official demise of the total-package procurement concept during its first application. In point of fact, Secretary of Defense Melvin

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[6] A summary of the salient changes to the engine contract and the final cost arrangement is included in Appendix 3, along with similar information on the restructured airframe contract.

Laird had repudiated the TPPC in mid 1969, when he ordered the reform of procurement policies, and Deputy Secretary Packard responded by unleashing major changes in the weapon system acquisition process. Packard reintroduced, if only for certain weapons programs, the practice of prototyping or conducting "fly-off" competitions between systems vying for development contracts. In any case, even though Supplemental Agreement 1000 restructured an existing contract, it promoted some of the new administration's basic procurement concepts.[20]

To begin with, under the terms of Supplemental Agreement 1000, Lockheed agreed to waive all existing claims as well as rights to performance incentive payments, and to give up any "profit or fee for spare parts and other...items to be supplied." In addition, Lockheed agreed to accept "extraordinary management controls" by the government. The agreement also canceled a number of provisions that had been part of Charles's total-package procurement contract. The deletions included responsibility for total system performance; the pricing of government-imposed changes; repricing; and adjustment for economic fluctuations. Finally, the new agreement included management practices that, in effect, totally rescinded McNamara's policy of centralization. Supplemental Agreement 1000 sought to combine increased management controls with decentralization.

The so-called "Packard Initiatives" for major Air Force weapon projects had by late 1969 shifted the Program Element Monitor for the C–5A from the Air Staff to the Air Force Systems Command. By May 1971, when the new agreement with Lockheed became effective, general officers were routinely assigned as program directors, rather than colonels. Essentially functioning as managers, directors of system project offices controlled every important aspect of the program to which they were assigned. Under the decentralized Packard policy, AFSC expected its system project offices to balance performance, schedule, and cost in the programs they managed. Other refinements in acquisition policy specifically addressed the problem of controlling costs, but these appeared too late to affect the C–5A program. Nevertheless, under the close control of Brig. Gen. Warner E. Newby, who had replaced Colonel Beckman as C–5A program director on July 21, 1970, the revamped program overcame incredible technical difficulties, acquired respectability, and ultimately provided a major asset for America's strategic airlift forces.[21]

Another Crisis

Weight problems can affect any aircraft, and Lockheed's gigantic C–5A proved especially vulnerable. In the spring of 1965, the Air Force reduced some of the C–5A's technical requirements for the specific purpose of decreasing the proposed transport's weight. Yet, even though the final design submitted by Lockheed featured the heaviest operating weight among the competitors, it promised the lowest cost, which clinched the September decision in favor of that firm. The Air Force, however, did not reduce those technical requirements affecting operational performance, and Lockheed embarked on a difficult course of action, shaving weight without undercutting effectiveness.[22]

The C–5A contract, when signed by Lockheed, stipulated that the aircraft's guaranteed tare weight—the weight when ready to fly, excluding the crew, fuel and oil, payload, and various consumables—would not exceed 318,469 pounds. Lockheed was within this weight envelope in January 1966 and even reduced the figure to 311,546 pounds the following month, but ensuing wind-tunnel tests revealed that aerodynamic drag would prevent the aircraft from having the required range. Changes in the shape of the airframe to increase range required structural modifications that raised the aircraft's tare weight to 319,778

pounds triggering another weight reduction effort. In the process of saving weight, the contractor altered the original high-lift airfoil design by switching from a double-slotted, trailing-edge flap and leading-edge Krueger flaps to a conventional Fowler flap on the trailing edge and slats on the leading edge.[7] Although other changes would have to be made to reduce weight, the immediate results appeared encouraging. In late 1966, the C–5A's estimated tare weight was 319,274 pounds, a 504- pound reduction from the highest figure. By 1967, however, Lockheed's apparent improvements began impressing Air Force officials as hollow achievements, possibly the result of deliberate deceit.[23]

The most serious weight-related problem, one the Air Force would not completely solve for almost two decades, surfaced before the awarding of the C–5A contract but escaped notice. The request for proposals issued by the Air Force in 1964 instructed the competing airframe companies to specify technical performance values—like the range and payload of the new transport—that would become part of the contract. Wing area was not one of the items specified in the contract. To remain competitive in technical performance, Lockheed increased the wing area (and lift) of its revised design, which also increased tare weight of the proposed airframe. To meet the technical performance requirements, however, Lockheed decreased the estimated weight of its new wing structure even below that of earlier and smaller one. In reviewing the proposal, the Air Force focused exclusively on overall tare weight and never challenged the unexplained reduction in the weight of one vital component, the wing.

By early 1967, Air Force officials realized that the stress values of the new transport's wings left little margin for potential static overloading or the effect of metal fatigue. Lockheed agreed to deal with the problem, but subsequent events proved the contractor to be either unwilling or unable to comply. By mid-1970, when wing fatigue began to occur, the fortieth C–5A was being assembled and Lockheed employees were already machining wing parts for the sixtieth airframe. The time had passed for a major redesign of the wing structure. Moreover, the recently revealed dispute over cost overruns, the Congressional debates about the airplane, and the attendant reduction in C–5A procurement tended to obscure the importance of providing a stronger wing.[24]

Other problems also arose long before production started. The contractor's engineers conceived of the C–5A as a larger version of the C–141, and grossly underestimated the technical difficulties involved in increasing the diameter of the fuselage. Moreover, Lockheed had not conducted sufficient wind tunnel tests on scale models of the airframe before signing the unique total-package procurement contract. Indeed, in its eagerness to win the production contract, Lockheed might well have minimized wind-tunnel testing or ignored the problems the tests revealed, just as the firm could have deliberately have underbid its rivals.

From the start, the C–5A required materials handling procedures and manufacturing techniques different from those of the C–141. Installing the huge stringers, which held the airframe structure together during fabrication, required extra workers; special machine tools had to be designed or altered, and more expensive materials took the place of aluminum. At the plant in Marietta, Georgia, the costly use of titanium, metal bonding, honeycomb structures, and chemical milling helped keep the aircraft's weight meet the contract specifications.[25]

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[7] The Fowler flap is set into a wing's trailing edge in a manner similar to a split flap, but the Fowler moves backward and swings downward thus increasing wing area and camber -- and therefore lift -- with a minimum amount of drag.

In November 1968, eight months after the beginning of the Category I tests, which sought to discover deficiencies in design, Lockheed detected cracks in the fuselage frame of one C–5A. The cracks varied in size, but some were one-eighth of an inch wide and 12 to 16 inches long. Lockheed attributed the cracks to overstressing that resulted from parts being poorly fitted on the assembly line. The ultimate cause, Lockheed believed, was a lack of coordination among various subcontractors. In early December, engineers from the program office met with their counterparts at Lockheed to evaluate measures to resolve the problem and prevent its recurrence. Although admitting that Lockheed had made some efforts to correct tooling and design errors, Air Force officials insisted that the manufacturer draw up a comprehensive plan for engineering inspections to locate and correct discrepancies.[26]

Structural failings, like the cracks in the C–5A's fuselage, sometimes occur in a new aircraft. Environmental corrosion or accelerated metal fatigue, the latter often the result of pushing the aircraft beyond its designed performance envelope, induced structural failure. Even though the Air Force knew the dangers of corrosion and metal fatigue from its experience with other aircraft, the problem with the C–5A was not corrected immediately and would reappear several years later in a more serious form. On September 29, 1971, an outboard engine on a C–5A turned to full power for takeoff at Altus AFB, Oklahoma, pulled free of its mount, resulting in the immediate grounding of all C–5As.[27]

In the meantime, other flaws appeared in the C–5A. During 1968 and 1969, testing of the first two aircraft disclosed that the main landing gear did not work properly. The enormous landing gear assemblies were an innovation. Located amidship beneath the fuselage, they were constructed in four, six-wheel gear bogies which rotated ninety degrees and folded inward after takeoff, and there were also four wheels to support the aircraft's nose. Lockheed attributed the landing gear's malfunction to the "interim configuration" of the first two C–5As, which functioned as test aircraft. The next aircraft, however, experienced similar problems.

Correction of the landing gear took several years. In January 1971, following completion of an engineering study headed by Raymond L. Bisplinghoff of the Air Force Scientific Advisory Board, Lockheed started recording malfunctions of the 28-wheel landing gear truck, and found out that on an average one malfunction occurred for every eight cycles of extraction and retraction. Lockheed's attempts to improve the landing gear's electronic controls proved futile, and the system had to be largely redesigned. As a result, a simplified system involving relays and switches replaced the solid-state electronics. The Air Force determined that the simplified system extended by 68 percent the mean time between failure, and decreased the man-hours devoted to maintenance by nearly 50 percent. Over a period of ten years, this might well amount to a saving of $123 million.

The committee's report, completed in June 1970, reached mixed conclusions. The committee found the design of the landing gear sound from an engineering standpoint, and blamed the gear's overly intricate construction for the problems, which were not "likely to cause a major accident if proper emergency procedures are followed." Just the same, the committee recommended that C–5As undergo additional operational testing.

As a result of Category II testing, which included actual operations, the C–5A Program Office realized that the pneumatic kneeling device for the nose landing gear, designed to load cargo more efficiently, would never work as planned. A hydraulic system, more reliable and easier to maintain, replaced the pneumatic system on all but four aircraft. The ten-year savings in operations and maintenance funds resulting from the substitution of the hydraulic system were expected to reach $7 million. Finally, Lockheed successfully modified the landing-gear-door locks, which sometimes popped open in flight; installation of the new locks on all C–5As was completed in mid-1973.[28]

The leading edge slats posed another problem. The 14 slats on each wing, manipulated by hydraulic actuators, occasionally failed to extend properly during landings. The system's

erratic performance convinced Lockheed that airflow and the aircraft's maximum takeoff weight (MTOW) caused the problem. In 1969, the manufacturer decided to redesign the "moving island portion" of the slat system.[29]

Besides dealing with cracks, the slats, and the landing gear, the Air Force encountered problems with the doppler radar, the radar altimeter, and other important subsystems and components. In 1969, however, the Air Force began struggling to solve the C–5A's most critical, most stubborn, and costliest problem. In July, the wing of a full-scale, statiC–test vehicle failed during a simulated 2.25-g pull-up maneuver with a payload of 265,000 pounds.[8] Failure occurred at approximately 125 percent of the design load, although the specification required for this test was 150 percent. Project Wing Strap strengthened with aluminum braces the wings of all C–5As The work, which reduced maximum takeoff weight from the planned 769,000 pounds to 575,000, ended by mid-1970; but the problem, far from being solved, was just beginning.[30]

Damage Control

The most urgent goals facing the newly appointed Secretary of Defense, Melvin Laird, as he inherited the C–5A program in 1969, included calming public opinion, enlisting Congressional support, and solving Lockheed's financial plight. The company's rehabilitation would mean nothing, however, if the C–5A did not perform as expected, and technical problems persisted. The Air Force had long suspected many of these problems but on occasion had failed to realize their potential seriousness. Although the Air Force had sometimes been less than alert, total-package procurement had limited the participation of the Air Force and the C–5A program office in Lockheed's development and production of the aircraft. The original C–5A contract likewise restricted the Air Force in its ability to correct technical deficiencies. Indeed, given manufacturer's past success, the need for Air Force interference seemed laughably improbable. If the unthinkable should happen and Lockheed-Georgia fail, one incredulous Air Force official joked, "We will get the sheriff and go to Atlanta."[31]

In February 1970, following the January discovery of wing cracks on a C–5A undergoing preparation for the Wing Strap modification, Air Force Secretary Seamans directed the Air Force Scientific Advisory Board, assisted by a disinterested panel of experts in aerodynamics, to conduct a technical study of the C–5A's wing structure. The review proceeded under the direction of Dr.
Bisplinghoff, both a member of the Scientific Advisory Board and Dean of Engineering at the Massachusetts Institute of Technology. Although at first concerned exclusively with the aircraft's wing structure, the scope of the Bisplinghoff committee's study soon expanded when Secretary Seamans asked it to review the landing gear, avionic subsystems, and overall performance of the aircraft.[32]

The committee decided that the aircraft's flight performance met specifications and that the contractual changes approved by the C–5A program office had not adversely affected technical performance. However, the avionics subsystems needed significant improvements in order to provide a "versatile and comprehensive navigation, flight control and landing

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[8] One "g" is the measure or value of the gravitational pull of the earth, or of a force required to accelerate or decelerate any freely moveable body at the rate of approximately 32.16 feet per second per second.

capability." In addition, the multi-mode radar and the inertial doppler navigation equipment were proving operationally unreliable. To provide pitch, roll, and heading information, the committee recommended adding a third attitude heading reference unit to the inertial doppler navigation equipment.[33]

The Bisplinghoff Committee's salient conclusions seemed grim. The sophisticated multi-mode radar system performed so poorly, the committee stated, that the Air Force should replace it with a less complex, commercially available system, or use an interim state-of-the-art weather and mapping radar until the performance of the multi-mode radar improved. As for the wing, which had led to the formation of the Bisplinghoff Committee, the report recommended, at the least, further strengthening the fuselage and wing, preferably linked to restrictions on payload and mean takeoff weight and modifications to the wing that would channel the flow of air inboard of the tip closer to the root, thus reducing the wing loading. Whatever was done, the C–5A seemed unlikely to last as long as planned because of high operational stress levels caused by the effect of weight and sudden maneuvers on a flawed wing structure.[34]

In June 1970, the results of the Bisplinghoff review caught the attention of the media. Allegations surfaced that the C–5A's many structural problems would limit the aircraft's life to one-fourth of the 30,000 flying hours sought by the Military Airlift Command, that no possible fix could prolong the existing wing's lifetime to that extent, and that the Air Force should consider beginning all over by designing an entirely new wing! Secretary Seamans did his best to quell the rumors and answer the media's charges, openly stating that a major redesign of the wing was "very unlikely." Seamans admitted that additional modifications to the wing structure and other measures would be required to provide an operationally useful airplane, but he insisted that the committee report reaffirmed his conviction that the C–5A "can perform the primary mission for which it was built."[35]

Of course, Lockheed's ongoing financial problems and the C–5A program's highly publicized cost overruns fueled the flames of media curiosity. Obviously, any modification, structural change, or subsystem replacement would again raise the aircraft's already formidable cost. Supplemental Agreement 1000, Lockheed's restructured contract of May 1971, stopped the reporters' new line of questioning, at least for a while, by giving greater control to the Air Force in general and the C–5A Program Office in particular. The program office, now freed from the restrictions of total-package procurement, could closely scrutinize Lockheed's management and quality control activities, two areas where the contractor had been inattentive at best.[36]

With its new oversight responsibilities, the C–5A Program Office's total manpower jumped from 72 in July 1970 to 105 in June 1971. The number of officers almost doubled, while the civilian complement, larger than the military element to begin with, rose by 30 percent. Despite reinforcing the program office, the task facing the Air Force remained staggering, for Lockheed was in deep trouble. Even though Lockheed's monthly production rate had declined to just two C–5As, the company might not be able to meet even this timetable while making the necessary adjustments on the production line. Testing of the few aircraft available for that purpose still lagged. The Bisplinghoff Report focused attention on the aircraft's most important problems; but defects of lesser magnitude remained, some innate in the aircraft's design, others due to poor workmanship, and these, too, had to be eliminated.[37]

Air Force project officials knew only too well how a flaw, undetected or seemingly minor, could have serious, even fatal, repercussions. On June 6, 1970, Gen. Jack Catton, the MAC Commander, piloted the first operational C–5A, to Charleston AFB. As the plane

touched down, a tire on one of the main landing-gear trucks blew out, and a wheel came off another truck and bounced wildly down the runway, an especially embarrassing mishap since it happened before an assemblage of military officers and civilian officials, including Rep. Mendel Rivers, an enthusiastic supporter of the new transport. General Catton told reporters that a lock washer was probably defective causing a nut to become unscrewed and allowing the wheel to fall off. "What we don't know," the general added, "is why the washer came off." A few months later, while maintenance men were purging a fuel tank to find a leak, a C–5A caught fire and exploded, killing one mechanic and injuring another.[38]

Safety, on the ground or in the air, was a constant concern to the Air Force. The Air Force had encountered malfunctions of weapon systems before and knew it had to correct even the smallest flaw. Not every attempt to correct a failing succeeded fully or immediately, but the service pressed on.

Metal fatigue and corrosion, often interrelated and always difficult to predict, proved especially hard to correct. Titanium metals and bonded honeycomb panels used in the C–5A to reduce the aircraft's weight, were highly susceptible to both problems. Moreover, cracks in high-strength, light-weight metals and plastics spread rapidly; the fracture could start in a corroded area—in a fastener hole, for example, or in a scratch or a poorly designed element of the aircraft structure. The effects of corrosion and fatigue were demonstrated by the accident in September 1971 at Altus AFB, which destroyed an aircraft when the number one engine and pylon tore loose from the wing of a C–5A preparing to takeoff. Investigation revealed a 1.35-inch-long crack on the inboard titanium longeron. Fatigue failure of the inboard cap of the aft pylon truss accounted for the separation.[39]

The root cause, however, lay in the design of the pylon's aft truss and therefore required the development of a new pylon. In the meantime, during the temporary grounding that ensued, all pylons were inspected. Those with a great many flying hours or cracked aft trusses, were judged defective and replaced on 21 C–5As, using existing pylons, those with poorly designed aft trusses. The replacements, either taken from storage or removed from grounded aircraft, went into service by the end of May 1972, enabling 18 engines to remain in service. A newly designed pylon survived thorough testing and by 1972 had accumulated 52,000 cyclic test hours, thus guaranteeing a minimum service life of 13,000 hours. Installing the new pylon began in April 1972 and ended the following year, after every C–5A had received the new pylons.[40]

Nor could the Air Force overlook the poor performance of the C–5A's avionics systems. Lockheed's testing of numerous new avionic components remained two years behind schedule. Moreover, many of these components were prototypes yet to be integrated in the aircraft. In other words, no one truly knew how they would work when melded into a unified system. Indications abounded that the problems of some of the most important subsystems would not be easily solved. For example, the original configuration (C model) of the multi-mode radar consistently performed so badly that, as recommended by the Bisplinghoff Committee, a commercial weather and mapping radar system developed by the Bendix Corporation underwent testing as a substitute. Unfortunately, the Bendix system would at most provide an interim solution, and at an unacceptably high cost. The C–5A Program Office therefore recommended continuing the development of the existing multi-mode radar program, and the Air Force Systems Command agreed. Hence, an improved configuration of the original C model was installed in one aircraft and tested in June 1970. The operational reliability of the multi-mode radar's updated configuration (the C–plus model) improved, and renewed testing of the basic C model provided answers to many of the system's remaining deficiencies and limitations. Pending replacement sometime in late 1972 of the updated C–plus configuration

by a further improved D model, MAC limited radar operation to horizontal modes (ground mapping, weather contour, and beacon operation). In addition, to minimize maintenance and conserve spare radars, and avoid depleting production capacity in sustaining operations of the Military Airlift Command, the C–5As used only one radar frequency band on an as-needed-basis, and with a 20 percent reduction in power.[41]

Installation of the new D-model multi-mode radar started as expected in October 1972, and was supposed to end within two years, around October 1974. Installation of the updated hardware proved a major undertaking, but the new multi-mode radar, if not a complete success, represented a significant improvement over the C model. The defects of the C and C–plus radars had been eliminated, and the D configuration functioned as a true multi-mode radar, not only capable of operating in the horizontal mode, but also in the vertical (radar approach, contour mapping, terrain following, and terrain avoidance). Reliability remained a problem, however, but program officials optimistically believed the subsystem might become fully effective before too long.

Another of the Bisplinghoff Committee's recommendations also proved impractical. The panel suggested improving the reliability of the Northrop company's inertial doppler navigation system by substituting a new inertial measurement unit supplied by Litton Industries. The Litton device performed well, but converting to its use would have cost $52 million and required a five-year effort. Instead, the Air Force settled for updating the Northrop radar in 1972, although the manufacturer continued to have problems of quality control.[42]

The last major problem, the wing cracks initially responsible for convening the Bisplinghoff panel, remained unsolved; indeed, if anything, it seemed to have become worse. As intended, the Wing Strap modifications reinforced the strength of the C–5A wings, but the additional weight of the necessary braces induced metal fatigue. By November 1970, an already reinforced wing developed numerous cracks in a full-scale fatigue test. This setback prompted Bravo Mod, a second modification of the wing accomplished in 1971. Pending completion of Bravo Mod, the projected flying life of existing C–5As declined from 30,000 flying hours to no more than 2,250. Bravo Mod was expected to extend the C–5A's service life from 2,250 to about 7,000 flying hours—a long way from the earlier 30,000 hours.[43]

To alleviate the urgent wing problem, the Air Force endorsed the Bisplinghoff Committee's recommendations to incorporate a Lift Distribution Control System in the C–5A. This system involved the re-rigging the ailerons to decrease lift on the outboard wing sections and increase lift on inboard wing sections, thus reducing wing bending movements at the inner and mid-span wing joints. Development testing of the Lift Distribution Control System ended successfully in 1972, and testing of production hardware was scheduled for 1973. The Lift Distribution Control System was expected to increase the C–5A's service life from the current estimate of 7,000 hours to a total of 13,000 hours, without exacting more than a nominal penalty in performance. The modification would cut range by no more than five percent, and lower the aircraft's operating ceiling by only 1,000 feet. Until the Lift Distribution Control System entered service, an Operational Utilization Management Program, initiated by the program office to increase the C–5A service life, imposed operational restrictions on the airplane. These required reduced-power takeoffs, imposed a fuel load of 130,000 pounds for local training flights, reduced the frequency of touch-and-go landings, and called for rotating aircraft through the training cycle instead of using a few specifically for the purpose. Manual uprigging of ailerons in flight, which altered the lift distribution over the wing in order to reduce bending at the wing root, became a standard flying technique. Air Force engineers concluded, however, that reducing the weight of fuel

carried on board provided the best method of preventing metal fatigue decrease restrictions, though transferring fuel from tank to tank to equalize weight during flight would also help. These restrictions reduced the aircraft's range, of course.[44]

The C–5A Problems That Remained In 1972

As early as 1970, Category I testing, initiated by Lockheed in February 1968 to uncover design deficiencies, had identified a multitude of flaws in the airframe. The Air Force Systems Command assumed responsibility for making corrections deriving from the Category I tests. This work could only be done where a skilled work force with heavy equipment could rebuild an airplane, insofar as necessary, not only making structural changes to correct problems but also updating various components and incorporating any changes made on the assembly line since the aircraft entered service. Modifications dictated by the Category II tests, which evaluated the aircraft's performance in a simulated operational environment, would be handled by both the contractor and the Air Force Logistics Command's San Antonio Air Materiel Area. Officials of the Aeronautical Systems Division estimated in 1970 that the updating the C–5A fleet would require 800,000 manhours; Lockheed, in contrast, estimated 1.4 million manhours. Pit Stop, the contractor's team approach to depot-level work, involved replacement of "urgent items" on operational aircraft, for example, those affecting safety.[45]

Lockheed, however, could not start work as soon as the Air Force wanted. Because the San Antonio facility could handle a great deal of the required depot-level work with Air Force civilians, paid less than Lockheed labor, the Air Force decided that the air materiel area would do most of the updating, beginning in December 1970. Since the C–5A production line continued to operate during the updating and modification program, the Lockheed work force, using space in the Marietta plant, faced the task of incorporating critical changes in the aircraft being built there. The need to build and update at the same time promised to interfere with scheduled production, already proceeding at a leisurely pace. Moreover, the Lockheed had to be ready to deploy its Pit Stop teams on short notice to assist the San Antonio Air Materiel Area.[46]

The Air Force had experience in updating and depot-level repairs, a definite advantage. Even though some of the C–5A's deficiencies were unique to that aircraft, most defects proved easy to fix, of the kind routinely found in a typical new weapon system. Despite the public debate and widespread misgivings, it was just a question of time before the C–5A program began to fulfill expectations and contribute to the war effort in Southeast Asia. Performance of the General Electric TF39 turbofan engine, for example, steadily improved, as the General Electric Company promptly took care of any deficiencies. After C–5A pilots reported in mid-1970 that the engine's anti-icing system malfunctioned when the aircraft operated for long periods under heavy icing condition, the manufacturer need only one year to develop an improved anti-icing system for evaluation at the Air Force Arnold Engineering Development Center, Tennessee, and further testing at the General Electric's Evendale plant in Ohio. Test results were good, and the improved system began functioning by the end of March 1972.[47]

Despite success in updating, modifying, and sometimes replacing components, one critical problem stood out—structural weakness of the wing. It would take more tests, more money, and many more years to solve this problem. On January 25, 1972, Secretary Seamans informed the House of Representatives that the life expectancy of the C–5A's wing fell far short of the required 30,000 hours. At this time, the secretary admitted, the Air Force still estimated projected a lifetime of between 7,000 and 8,000 flying hours after modification of

the wing; but the service had already taken measures to minimize fatigue and developed plans to increase the aircraft's service life to 20,000 flying hours. Secretary Seamans was referring to the utilization restrictions that the program office had recently imposed on operational C–5As, as well as to the various modifications being considered and the Lift Distribution Control System under development and soon to be tested.[48]

In the last days of January 1972, immediately after addressing Congress, Secretary Seamans directed formation of an independent wing structural review team. The team, consisting of approximately 100 engineers, went to the Lockheed-Georgia facilities, examined thoroughly the C–5A's airframe and wing structure, and recommended ways to increase the plane's useful life. Although the team's report was not expected before March 1973, the Air Force received some advance information earlier. The review panel concluded that, with the exception of the wing, the C–5A was unquestionably a 30,000-flying hour aircraft, and modifications could extend the lifetime of the wing. Without the future Lift Distribution Control System, the C–5A's flying life expectancy would be between 8,000 and 10,000 hours; with the control system, the plane's life span approached the 11,000 to 16,000-hour range.

Besides forming an independent team of engineers in January 1972, Secretary Seamans directed Lockheed to undertake a special study of the C–5A's problems, a part of a so-called Wing Life Improvement Program that the firm had already begun. The Wing Life Improvement Program, although focusing on the wing, dealt with other components and included full-scale fatigue testing, the fatigue-tracking of individual aircraft, and the analytical condition inspection of selected aircraft undergoing depot-level maintenance. In addition to the many reviews directed by Secretary Seamans at the beginning of the year, Secretary of Defense Laird in May 1972 requested that the Office of the Air Force Deputy Chief of Staff for Research and Development cooperate with the Air Force Systems Command in a fact-finding effort to assess the C–5A's current capabilities, determine which major modifications were needed to upgrade the aircraft's performance, and estimate realistically the costs of these potential changes.[49]

Amid the continuing investigations, fact-finding studies, and projected improvements, the Military Airlift Command reviewed the C–5A program as 1972 came to a close and decided that the aircraft's future looked promising. The command pointed out that the C–5A's structural problems were not unique, nor even novel, and had often appeared in new production aircraft. MAC's leaders believed that close congressional scrutiny of the program and resulting publicity had led many people to assume that the C–5A would not remain in the inventory long enough to be cost-effective, an assumption, these officials asserted, that would prove totally unfounded. The C–5A had already shown that it could perform its day-to-day strategic airlift role very well, and that the aircraft's first actual deployment—to Southeast Asia—had been particularly impressive.

The Military Airlift Command did not belittle the C–5A's structural deficiencies, and admitted the aircraft's service life had been a problem of increasing magnitude since the first major structural-test failure of 1969. The problem, however, needed to be viewed in proper perspective. Design objectives for the C–5A called for a maximum takeoff weight of 728,000 pounds, with a maximum cargo of 220,000 pounds and a maximum maneuver load of 2.5gs. Command officials acknowledged in late 1972, that pending successful completion structural demonstration testing, operational C–5As remained under strict restrictions. In other words, as validated by previous structural testing, the aircraft were still operating at about 80 percent of designed capacity. Maximum takeoff weight could not exceed 712,500 pounds, maximum payload 174,000 pounds; and the maximum maneuver load only 2.0 gs. However, in the command's opinion, this reduction in payload did not result in a crucial decrease in

performance because distance and weather normally limited actual C–5A payloads to less than 180,000 pounds.[50]

Between the arrival of the Nixon Administration in 1969 and the end of 1972, Lockheed had moved away from the brink of bankruptcy, and the near collapse of the C–5A program had been averted. Total-package procurement no longer applied, the C–5A production was almost completed, and numerous aircraft deficiencies were corrected or nearly so. A major structural problem remained, but the Air Force had identified its causes, effects, and most of the modifications necessary to rectify it. Leaders of the Military Airlift Command could now believe without reservation that the C–5A program would prove a real contribution to the nation's airlift fleet.

Endnotes

1. Nelson "Kennedy's Policy," pp. xx.
2. Francillon, "Galaxy," pp. 270-71.
3. Comments by Dr. Richard K. Smith on draft MS.
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CHAPTER V

THE END OF THE C–5A PROGRAM AND THE BEGINNING OF THE C–5B

By the time production ended in 1973, the C–5A had become a key element in a national military strategy of flexible response, but the cost overruns and controversy that surrounded its development and production utterly discredited a once-promising technique for controlling the cost of weapons, total-package procurement, and nearly bankrupted Lockheed, the prime contractor. When Lockheed, General Electric, and the Air Force incorporated essential changes like a redesigned wing and desirable features like an improved General Electric engine, the C–5A not only performed as designed but also served as the basis for the C–5B which entered production in the 1980s. In effect, the older A-models became C–5Bs.[1] . . . . . .

The C–5A became operational during the Vietnam War, which ended for the United States with the ceasefire of January 1973. In November 1970, only two months after MAC's first C–5A squadron attained an initial operational capability at Charleston Air Force Base (AFB), South Carolina, airdrop tests began under simulated operational conditions. The TADJET program, as it was known, combined Category I and II Transport, Airdrop, and Jettison tests. TADJET took place between April and August 1971 at Fort Bragg and Pope AFB, both in North Carolina, and experienced no serious difficulties. The first 40,000-pound cargo drop occurred on April 29, 1971, and on the same date, the first jump by paratroopers took place from a C–5A flying at an altitude of 2,000 feet and at an airspeed of 130 knots. On June 30, 1971 only a few months behind schedule, the Air Force achieved its goal of dropping 73 paratroopers from a single C–5A flying at an altitude of 2,000 feet and at an airspeed of 130 knots. The TADJET program, completed in August 1971, proved the C–5A to be an outstanding airdrop platform for both cargo and paratroopers. When a C–5A dropped four 40,000-pound pallets sequentially on a single pass, the total change of pitch above the horizontal, as the weight cleared the cargo compartment, amounted to only seven degrees. By mid-1972, more than 1,400 paratroopers had jumped safely from the C–5A, even though the main purpose of the aircraft was to carry bulky cargo.[2]

By September 1971, the Air Force could with confidence furnish a C–5A to haul cargo in support of the National Aeronautics and Space Administration's Skylab space station program. On the 27th and 28th of that month, NASA and Air Force personnel at Ellington Air Force Base, Texas, tested procedures and equipment for loading and unloading the Skylab Mobile Medical Laboratory, part of the Apollo XVII flight recovery operation. In December 1972, a C–5A flew the unit from Ellington to North Island Naval Air Station at San Diego, California, where it was subsequently loaded aboard the prime recovery vessel, *USS Ticonderoga*. These important accomplishments tended, however, to be obscured by continuing concern over the recurring slippage in production and the aircraft's unsolved wing problem.[3]

Overseas Deployment

The structural weakness of the C–5A's wings brought stringent operating precautions and flying restrictions to ensure safety and minimize the impact of fatigue on the aircraft's already limited service life—a mere fraction of the 30,000 hours of flying time for which the plane was designed. Because Air Force officials insisted that air refueling put considerable stress on this aircraft—when in actuality the shortage of Boeing KC–135 tankers used in

refueling may have caused the problem, or at least contributed to it—this valuable technique had to be abandoned. To make up for the shortage of KC–135s, the Air Force would buy a tanker version of the Douglas DC–10 commercial transport.

Even though the C–5As left the factory fully equipped for inflight refueling, the Air Force felt it could not take advantage of this asset, citing the restrictions on maneuvers by the transport. The restrictions, intended to extend the useful life of the C–5A, reduced maximum takeoff weight to 712,500 pounds, maximum payload to 174,000 pounds, and range to 3,250 nautical miles, the last a result of a lesser weight of fuel. Despite the restrictions, no other aircraft in the world could even come close to matching the C–5A in performance[4]

As the leaders of the Military Airlift Command pointed out, the transport could do a valuable job regardless of program slippage and operational limitations. For example, a round-the-world flight in July 1970 demonstrated the range of the C–5A without aerial refueling, but the flight was more a stunt than a serious test of operational effectiveness. During the next twelve months, other flights without air refueling to Pacific and European bases succeeded admirably, departing either from Charleston, Dover, or Travis AFBs as part of operational testing.

The C–5A fell far short of perfection, as even its most enthusiastic supporters had to admit. Besides the plane's intrinsic structural problems, logistics support of the C–5A remained marginal, and maintenance and reliability continued to be unsatisfactory. The number of C–5As not operationally ready because of supply failure gradually dwindled after December 1971. Those not operationally ready because of maintenance problems fluctuated around 40 percent, and 60 or 70 hours of maintenance were required to keep a plane in the air for one hour. Dismal though these numbers were, the Air Force expected reliability to soar as depot modifications ended and mechanics acquired experience with the aircraft.[5]

The C–5A did not appear in South Vietnam in a truly operational capacity until August 1971, but in the months that followed the aircraft played a major role in the Southeast Asia airlift. In April 1972, when most American forces had left the theater as part of a planned withdrawal, North Vietnam invaded the South; air units had to be redeployed from the United States to Southeast Asia to contain the North Vietnamese Easter offensive. Besides flying cargo across the Pacific, the C–5A flew missions in the theater of war, on one occasion helping move some 3,000 South Vietnamese troops and 1,600 tons of cargo in just nine days. Before the Easter offensive, MAC had been reluctant to let any of its fifty-odd C–5As risk the threat surface-to-air missiles (SAMs). Unlike the C–141s and C–130s, the C–5As did not carry radar homing and warning devices to alert crews that a missile radar was tracking their airplane.

On May 3, 1972, a single C–5A, flying three sorties from Yokota Air Base, Japan, carried six Army M48 tanks, each weighing 98,000 pounds, to the forward airfield at Da Nang in South Vietnam. As the C–5A came to a stop, its cargo door opened and ramps extended so the tank drivers could start their engines and drive off under their own power, a sequence that took just seven minutes. Total time on the ground in the dangerous forward area amounted to 30 minutes or less. Immediately after this airlift, C–5As moved M41 tanks and M548 tracked vehicles to Da Nang and to Cam Ranh Bay, also in Vietnam.[6]

The C–5A accomplished another spectacular mission on May 11, 1972, making a nonstop unrefueled flight of 8,019 statute mile from Kadena Air Base, Okinawa, to Charleston Air Force Base, South Carolina. The flight lasted 16 hours and five minutes, at an average ground speed of 527 miles per hour, and set a new nonstop distance record for the C–5A. Altogether, C–5As flew 109 special assignment missions in Southeast Asia during May, transporting 5,450 tons of cargo. In late 1972, as the United States rushed weapons into

South Vietnam before a truce could take effect and limit deliveries to replacing items already in the inventory, the C–5As, between October 28 and November 28, flew 69 special assignment missions without in-flight refueling. They airlifted 3,000 tons of cargo that included 32 Northrop F–5 Freedom Fighters and 66 Cessna AT–37s for the South Vietnamese Air Force, as well as CH–53 helicopters and mine-sweeping equipment for the U.S. Navy, and helicopter parts and communication equipment for the U.S. Army.[7]

C–5A cargo aircraft again demonstrated their unique advantages after the Arab armies of Syria and Egypt attacked Israel on October 6, 1973, advancing from the Golan Heights and across the Suez Canal. Although the United States took immediate action to help Israel, a refusal by Arab petroleum producers to sell oil to nations supporting Israel deterred America's European allies from granting landing or overflight rights to aircraft bound for Israel. The ban on aerial refueling still handicapped the C–5A, complicating the employment of that airplane, which like all other American military aircraft, could stage only through Portugal's Lajes airfield in the Azores before flying over the Straits of Gibraltar to Lod airfield in Israel—an average distance from the United States of 6,450 nautical miles.[8]

On October 13, 1973, a week after the invasion but only nine hours after President Nixon ordered the first emergency resupply operation, a C–5A loaded with 193,000 pounds of cargo was on its way to Israel. All the American equipment that reached Israel before the ceasefire of October 24 arrived by air, and MAC C–5As flew 145 missions in less than two weeks. Twenty-nine of these missions airlifted vitally-needed M48 and M60 tanks, cargo that could be carried only by the C–5A.

Notwithstanding the success of the aerial resupply of Israel, the entire operation brought into sharp focus a problem that would trouble the Air Force for years to come. That problem, first pointed out in 1953 by the Air Force Chief of Staff, Gen. Hoyt S. Vandenberg, involved the military risks of depending on overseas bases, which might be neutralized by either military or diplomatic action or simply prove inadequate. In late 1973 and early 1974, after petroleum diplomacy had barred flights to Israel from bases on the mainland of Europe, Gen. Paul Carlton, MAC's new commander, explained to the Congress that the limited facilities at Lajes Field in the Azores and the one-an-hour-refueling capacity at Lod Field in Israel severely limited strategic airlift during the Arab-Israeli conflict. After unloading supplies and before returning to the United States to pick up more cargo, the aircraft had to be refueled, a difficult undertaking because of the limited refueling capability at Lod. General Carlton revealed that MAC transports actually loaded more tons of fuel in Israel than the tons of cargo they delivered there. Fortunately, the Israelis had plenty of fuel, the MAC commander added, otherwise, the resupply operation would have ground to a halt in a hurry.

Despite the progress in aeronautical technology, Carlton said, unexpected difficulties always could develop—a case in point being the impact on range and payload caused by the C–5A's flawed wing—and the problems associated with the airlift to Israel could not be allowed to occur again. Until strengthened wings would enable the C–5A to engage in aerial refueling, the aircraft should fly only to airfields within the plane's unrefueled range and capable of rapid unloading and refueling. Since few countries could duplicate Israel's reserves of fuel, the Military Airlift Command should be able to deliver a million or more gallons of fuel each day. . . . . .

In conclusion, General Carlton underlined the importance of aerial refueling. Boeing KC–135 tankers had proved indispensable for the rapid delivery of fighters to Israel. Strategic transports of the Military Airlift Command also required air refueling if they could not be absolutely sure of refueling on the ground en route to the destination, or if the command wanted to avoid reducing an aircraft's payload in order to extend its range, but for

now the mid-air technique could not be used. The entire C–141 fleet lacked equipment for refueling in mid-air, which Lockheed would add when converting the C–141A into the stretched B-model. The C–5As were capable of aerial refueling, but current flying restrictions excluded maneuvers that put excessive stress on the aircraft's wings, and air refueling fell in that category. Moreover, the Air Force had bought the KC–135 expressly to serve the bombers of the Strategic Air Command and fighters of the Tactical Air Command, not the strategic transports. What was needed, Carlton said, was a large, wide-bodied, Advanced Tanker Cargo Aircraft (ATCA), which entered service as the KC–10 in 1982.[9]

Although the changes advocated by the MAC commander received widespread support within the Air Force, they did not materialize overnight. All 270 C–141A Starlifters were eventually fitted for air refueling, but the modification became part of a program to stretch the fuselage and increase cargo capacity. As a result of the process, the modified C–141A acquired a new designation, the C–141B. Lockheed, which had built the A-model, completed the conversion into C–141Bs two weeks ahead of schedule for $491 million—nearly $20 million below the cost listed in the contract.[10]

A Mixed Victory

Back in 1971, a strike against the AVCO Corporation, manufacturer of the wings for the C–5A, caused Lockheed to stop the production line and lay off employees. Once again the prime contractor's production schedule appeared threatened, and Air Force officials sighed with relief when the labor dispute resulted in only minor delays. The 81st and final C–5A rolled out of Lockheed's Marietta plant on January 31, 1973, and the Military Airlift Command accepted delivery of the aircraft on May 18th, only three months later than currently expected. The C–5A program, however, remained several years behind the original schedule, the quantity of aircraft had been significantly reduced, and the aircraft's service life was shortened by the structural weakness of its Avco-built wings.

The San Antonio Air Materiel Area in January 1973 assumed responsibility for the engines that powered the C–5A. The General Electric Company delivered the last of 464 TF39 engines in 1972. Many of these were TF39-1A models, with better performance and a longer operating life than those which originally powered the C–5A. After January 1972, all engines overhauled at San Antonio underwent upgrading before being released as TF39-1As.[11]

Its lingering problems notwithstanding, the accomplishments of the C–5A during both the Vietnamese and Arab-Israeli wars left scant doubt about its usefulness. Indeed, by the time production ended, American political and military leaders agreed that the C–5A was a very special flying machine—an awe-inspiring sight as it whistled through the sky. The C–5 resembled a winged building, six stories high at the tail, almost as long as a football field, and large enough to house 14 jet fighters, 50 Cadillacs, or any 174,000-pound assortment of military equipment.[12]

Despite its cavernous size, the C–5A proved easy for pilots to handle. Although stringent operating restrictions remained in effect in 1973, the aircraft demonstrated amazing operational performance. For example, its rate of climb at sea level reached 1,890 feet per minute, and its average cruising speed approached 450 knots. Moreover, the aircraft's four General Electric TF39-1A axial flow turbofan engines, each with a diameter of 16 feet and capable of generating 41,000 pounds of thrust, could produce enough electricity for a city of 50,000 people. With maximum allowable payload and without air refueling, the C–5A could fly 3,250 nautical miles, and its ferry range was more than twice that distance. With one aerial refueling, when that technique was permitted, aircraft carrying its maximum designed

load could reach almost any point on the globe.

Another important feature of the C–5A was its ease of loading and unloading. Since the cargo compartment opened at both ends, a truck or tank could drive in before takeoff and at the destination drive out under its own power, with no need for backing and filling. Integral cargo-loading ramps, stowed fore and aft in the cargo compartment, facilitated entry and exit. Finally, standard cargo-pallet rails, rollers, and restraints formed an integral part of the heavy duty cargo floor, folding away when not in use to provide a level deck.[13]

The C–5A also featured special avionics to permit it to hug the terrain at low altitude and pinpoint targets for airdrop at night or in adverse weather. Although many of these subsystems had presented difficulties, by 1973 they were functioning as designed. The aircraft could not land on unimproved airstrips, however, because the shock from rough surfaces, transferred through the fuselage, imposed a strain on the badly designed wings. Hence, the high-floatation landing gear, intended for dirt surfaces, was not needed. Similarly, the ability to use terrain-following radar at an altitude of a few hundred feet did no good because at such low altitude the rough air savagely buffeted the C–5A's vulnerable wing.

Despite these operating constraints, by 1973 the C–5A had proved itself a useful aircraft. As Gen. Howell M. Estes, then in command of military airlift, had predicted in 1966, the C–5A did not radically advance the aeronautical art, but for the first time it allowed the Military Airlift Command to fulfill a much broader spectrum of requirements. These airplanes would enable MAC to move a fully equipped Army division wherever such a force might be needed.

The end of C–5A production in January 1973 seemed the ideal time to assess the cost of the program. The airplane had proved far more expensive that planned, but no consensus existed as to why this happened. In 1971, Deputy Secretary of Defense David Packard declared that "the Air Force asked for more features on the C–5A than were really necessary," adding significantly to the cost. The Air Force disagreed, arguing that it sought only those features justified by experience. Secretary of the Air Force Seamans adamantly supported his service, insisting the C–5A reflected years of airlift operations from Berlin to the Congo and the Middle East to Southeast Asia. Gen. David C. Jones, the Air Force Chief of Staff, judged the C–5A to be a "fine aircraft . . . a good aircraft," and blamed total-package procurement for the excessive cost overruns that had already surfaced. General Jones conceded that certain overly ambitious specifications had contributed to the rising cost, but he also pointed out that Lockheed had erred in trying to meet Air Force demands for range and payload without increasing the tare weight. As a result, the wing structure proved too light to withstand the cumulative effects of landings, takeoffs, and aerodynamic drag.[14]

Whatever the reasons, Air Force leaders found the cost of the C–5A shockingly high compared to initial estimates. Only eight years before, on the eve of signing the contract in October 1965, the Air Force anticipated a maximum cost for 115 airplanes of $3.4 billion, which seemed a very generous sum, since it was about twice the amount of Lockheed's winning bid. This estimate projected a unit cost of $29.5 million, nearly five times the C–141A's unit cost of $6.3 million.[15]

Moreover, total-package procurement covered near-term inflation along with spare parts, and the Air Force provided the prime contractor with General Electric engines as government-furnished equipment. Lockheed also had free use of Air Force facilities. In November 1968, when Congress began investigating the cost overruns, the estimated price of the C–5A program had soared to more than $5 billion, or about $43 million for each of 115 aircraft. By mid-1973, when C–5A total production ended at 81 aircraft, the Aeronautical Systems Division of the Air Force Systems Command calculated two sets of figures for the

C–5A program. The first one set a unit price of $46.92 million, representing the total sum paid to Lockheed for each C–5A, regardless of the aircraft's condition. A second figure, the only valid one, calculated a unit cost of $55.37 million, which included the extra $9.45 million the Air Force had to spend on each and every C–5A for modifications. The aggregate cost of improvements, logistics support, aerospace ground equipment, and the replenishment of stocks of spare parts for the next five years brought the total cost of 81 aircraft to $4.48 billion, one billion more than initially agreed upon, *and* for 31 fewer airplanes.[16]

The $55.37-million price tag attached to each C–5A in 1973 clearly justified the program's reduction from 115 to 81 aircraft, three of which by then had been lost in accidents. Yet, other factors contributed to the reduction. By 1970, accumulated testing had already identified several problems with the aircraft's landing gear, cracks in the fuselage of an early C–5A, the structural weakness of the wings, and malfunction of the doppler radar and radar altimeter. The seriousness of the structural problem affecting the wings of the C–5A grew more acute as time passed until the Air Force could not be sure that the aircraft would actually perform as planned unless the wings were rebuilt. After the Senate voted in September 1969 to continue the program, Secretary Laird immediately endorsed the Air Force's previous decision to limit the program to a total of 81 airplanes. When production ended in 1973, the Air Force made no move to reinstate the canceled portion of the contract, despite the success of the C–5A in Southeast Asia and during the Arab-Israeli war.

Re-winging the Fleet

The flying restrictions imposed on the C–5A did not prevent the aircraft from performing day-to-day strategic airlift missions, but it seemed impossible that the C–5A could ever achieve its intended lifetime of 30,000 flying hours unless the aircraft received a new wing. Static fatigue tests, along with the appearance of cracks in the wings of operational aircraft earlier than expected, left no doubt that the C–5A wing structure had a service life of about 8,000 flying hours—roughly one-fourth of the design objective.

The Israeli airlift in late 1973 indicated that the demands on American strategic airlift would increase in the future. Indeed, early in 1974 Secretary of Defense James R. Schlesinger expressed his belief that the mobility of military forces held key to the future ability of the United States to help deter conventional conflict in Europe. In August, General Jones, the Air Force Chief of Staff, announced his decision to combine all airlift, tactical and strategic, in the Military Airlift Command. The decision to transfer tactical airlift from the Tactical Air Command to the Military Airlift Command and to make MAC a specified command reporting to the JCS was reaffirmed two years later, in mid-1976, and became effective on February 1, 1977.[17]

While the organizational structure of airlift underwent overhaul, the Air Force assembled an independent review team to examine the physical structure of the C–5A. In the spring of 1973, after more than a year of intensive work, the review panel affirmed that, except for the wing, the C–5A had the potential to perform as a 30,000-hour aircraft, but that the wing in its present condition could not survive much more than 8,000 hours of flying. The review team decided, moreover, that ad hoc repairs would not suffice and recommended designing and testing a heavier and more rugged wing. In November 1973, work began on what become known as the H configuration. The design used stronger center and inner wing boxes with a modified outer wing box, while retaining only the leading edges, pylons, trailing edges, and flaps from the original wing. In August 1974, John L. McLucas, the new Secretary of the Air Force, approved the H modification for the C–5A. Approval by the Secretary of

Defense Schlesinger followed in October, but he stipulated that the Air Force make sure that the redesigned wing could truly provide 30,000 hours of service.

The so-called H modification consisted of four phases: design of the new wing; fatigue and flight testing of two wing kits; production of wing kits; and installation of the rebuilt wings on the aircraft. The new H configuration was designed to reduce stress levels, provide better fastener systems and materials, and increase resistance to fatigue and fracture. To do all this, the wing had to survive a stress level of 12,000 pounds per-square-inch; prove through appropriate tests that it could endure 60,000 flying hours; and meet new military damage-tolerance specifications.[18]

In 1975, despite a downturn in the economy, an overall shortage of defense money, and the admittedly high cost of the H modification, the Department of Defense authorized the program's first two phases—design and testing. Though the go-ahead decision seemingly had nothing to do with recent strategic airlift operations, it followed on the heels of Operation Babylift, a tragic demonstration of the C–5A's versatility. Early in the year, when the Republic of Vietnam began collapsing under a North Vietnamese assault, MAC C–141s and C–5As rushed military supplies into the South and carried refugees out of the country. The Military Airlift Command airlifted some two thousand orphans out of South Vietnam in record time, but one C–5A, damaged when it experienced decompression of the cargo compartment shortly after taking off from Saigon's Tan Son Nhut airfield, attempted an emergency landing, but crashed short of the runway, killing 172 passengers, many of them infants.[19]

Despite the deadly accident, this humanitarian effort underscored the importance of the small C–5A fleet, but risking unarmed C–5As in a combat environment raised questions in Congress. In November 1975, General Carlton, when asked how far forward the C–5A would operate in combat, he replied that C–5As had already been used at Saigon and Da Nang despite the threat of the North Vietnamese SAMs. How far forward the aircraft might operate in the future would depend on whether the Joint Chiefs believed that carrying particular freight to a given point was important enough to justify endangering the airplane. Neither General Carlton nor his successors in command of MAC could make this decision unilaterally.[20]

Despite the increasing importance attached to aerial mobility, and the role of the C–5A in providing it, the rebuilding of the plane's wing progressed slowly. Although Deputy Secretary of Defense William P. Clements authorized the Air Force to proceed with the first two phases, design and testing, in June 1975, Lockheed did not receive the sole-source contract until December. Consequently, Phase I work on the design could not begin until January 1976. Moreover, in August of that year, even though the modification program's first two phases were still under way, the program was expanded to include a new outer wing box to replace the modified one. The Air Force believed the expansion of the program to be cost effective—an unchallengeable justification during a period of fiscal austerity—because a new outer box reduced the time required for inspection and repair while increasing the likelihood of achieving 30,000 hours in the air.

Cost effectiveness and the urgent need for the aircraft prompted the Air Force to convince officials of the defense department to give Lockheed a sole-source contract for the remainder of the C–5A's wing rebuilding program. The Air Force presented an abundance of details to justify Lockheed's receiving its second sole-source contract for re-working the wing. Lockheed had designed and produced the C–5A; and the company therefore possessed the necessary technical skill, industrial capacity, and experience not only to design and test the new wing—the program's first two phases—but to manufacture and install it.

Although the Air Force's San Antonio Air Logistics Center had the skilled labor and the equipment to install the strengthened wing boxes, it could not assume that task because the facility was booked for years to come updating B-52 bombers. The Air Force realized that hiring a contractor other than Lockheed to take over wing rebuilding would involve technical, manufacturing, cost, and scheduling risks. The intricate equipment required for the program would compel any new contractor to make a considerable capital investment. As a result, finding a substitute for Lockheed and its subcontractors could delay the program up to 21 months, whereas Lockheed was expected to meet the delivery schedule without adversely affecting the operations of the Military Airlift Command. Finally, other aerospace companies had not expressed any serious interest in competing for this contract.[21]

In September 1977, although recent fatigue tests had reaffirmed that the C–5A airframe, excluding the present wing. should last for more than 30,000 hours of flying, the Air Force embarked in a new structural program to make sure that the aircraft, with its flawed wing, could operate safely for a mere 8,000 hours. Despite some seven years of operating restrictions, test results in 1977 revealed that the service life of the wing had declined from 8,000 to 7,100 hours. Moreover, the Air Force's Scientific Advisory Board reviewed the data and verified this disappointing conclusion.[22]

Although a stronger wing was desperately needed, the intricacy of the program dictated caution. In December 1977, after reviewing Lockheed's proposed effort, ASD's Advisory Group described the contractor's approach as conservative and expressed confidence that the work would proceed smoothly. The schedule, however, could be accelerated only by beginning to rebuild the wings concurrently with testing, something that would require careful planning.

In June 1978, Lockheed completed the design of the new wing, the program's first phase. Completion of Phase II, fatigue and flight testing of two wing kits, was not expected before June 1983. During Phase II, one set of wing boxes would be installed on a C–5A earmarked for static fatigue tests and subjected to the equivalent of 60,000 hours; the second set would be tested on an operational C–5A. Phase II carried a price tag of $184.4 million. This sum included some $19 million representing the price of the two prototype wing kits built for Lockheed by the Avco Corporation, Lockheed's major subcontractor and manufacturer of the C–5A's original wing. By the end of October 1978, typical of the usual cost spiral, Avco's estimate had risen from $19 million to over $25 million, a problem for Lockheed to solve.[23]

Although the first two phases of the wing-strengthening program proved expensive, Air Force officials realized that this amount was a mere downpayment on the entire program. Nevertheless, Air Force and independent specialists regarded the re-winging program as cost effective, since it was one-fifth as expensive as replacing the C–5A with a new aircraft. Nevertheless, the total acquisition cost of the new wings, estimated in 1975 dollars, was $1.5 billion. Converted to unit costs the work would increase significantly the C–5A's price of $55.37 million, determined by the Aeronautical Systems Division in mid-1973 shortly after production of the aircraft ended.[24]

Meanwhile, danger signals were appearing all over the world. A chaotic revolution headed by the Ayatollah Khomeini overthrew the Shah of Iran, and in 1979 Khomeini's followers seized the American Embassy and took hostages. In the same year, American intelligence reported the presence of a Soviet combat brigade in Cuba, and at year's end Soviet military forces began invading Afghanistan. Although rapid reinforcement of the North Atlantic Treaty Organization forces remained the major concern of American defense planning, these ominous events raised the possibility of simultaneous deployments to meet

threats in different quarters of the globe. A buildup of American strength and the acquisition of costly new weapon systems, tactical and strategic transports included, would take time, however, and in 1980 it had barely begun. In the meantime, the C–5A modification program continued at a slow pace.[25]

In 1979, the Air Force and Lockheed began negotiating contracts for last two phases of the wing rebuilding program—Phase III, production of the repair kits, and Phase IV, installation of the strengthened wing on each C–5A. Phases III and IV, however, had to await successful testing of the new wing structure, Phase II, which began on August 28, 1979, and ended on May 9, 1980, five months ahead of schedule. In July 1980, the Air Force Scientific Advisory Board reviewed the conduct of the tests and concluded that Phase II provided an excellent approximation of operational usage and fostered confidence in the integrity of the design. A second series static fatigue tests, started in June 1980 and ended in June 1981, a year ahead of time.

In the meantime, on May 15, 1980, Lockheed finished installing the second prototype wing kit on the C–5A for flight testing and evaluation that started in mid-August at Dobbins AFB, Georgia. This program, totalling 55 flying hours and emphasizing flutter and similar problems, lasted through December 1980. A year of operational testing by the Military Airlift Command would follow.[26]

The Scientific Advisory Board's highly complimentary appraisal of the Phase II tests suggested that the beginning of Phase III would not be delayed and perhaps might be advanced. In late 1978, wary of accelerating the program, the Air Force had tentatively programmed Phases III and IV to begin in January 1980 and January 1982, respectively. The aircraft completion schedule—from March 1983 for the first re-winged C–5A to July 1987 for the 76th and last—provided for completion of all work before any single aircraft accumulated more than 8,000 flying hours, the old wing's projected lifetime. The deadlines for individual phases might slip, but the goal of completing the program before the most heavily used airplane attained 8,000 flying hours had to be met; venturing beyond that total was simply too dangerous.

As it turned out, Phase III and Phase IV of the re-winging program started as originally planned. In Phase III, the Aerostructures Division of the Avco Corporation in Nashville, Tennessee, manufactured the wing's center, inner, and outer sections from aluminum alloys that featured great strength and resistance to corrosion. Avco received this metal from the Aluminum Company of America's plant in Lafayette, Indiana, and from Martin Marietta Aerospace in Torrence, California. Lockheed bore the responsibility for assembling and installing the rebuilt wings, a task made more difficult because the new wing boxes had to fit the leading edges, pylons, trailing edges, and flaps retained from the old wings. Lockheed also used thicker material for the major structural components and subassemblies like the upper and lower skin panels, the beam caps and beam webs of the wing sections, and the joints at wing stations. In addition, Lockheed had to improve the fastener system, the methods of drilling the fastener holes, and procedures for assembly.

Though the on-going rebuilding program would not affect the basic aerodynamic shape of the original C–5A wing, changes required to reinforce the wing to the so-called H configuration added 18,000 pounds to each aircraft. This increase amounted to less than five percent of the C–5A's empty operating weight—or tare weight—of 326,962 pounds, but of course it meant reducing the C–5A's payload weight and fuel capacity by an equivalent amount. The recently devised lift distribution system, retained for the re-winged C–5As, helped compensate for the extra weight by improving takeoff, climb, and cruise characteristics. Moreover, reducing cargo weight by some 16,000 pounds (about one-fifth of

the tare weight) enabled the C–5A, with its rebuilt wing, to maintain a 769,000-pound takeoff gross weight at no sacrifice in range.

Finally, besides extending the wing's flying life to a minimum of 30,000 hours—the primary objective of re-winging—the program ensured a degree of structural soundness that ended the previous operating restrictions. For example, the C–5A could now carry a payload 190,000 pounds rather than 164,000 pounds, while the tare weight increased by more than 50,000 pounds—from 314,000 to 376,000 pounds. The Air Force could not have asked for a better outcome; not only did the re-winging accomplish its purpose, the program was accelerating. Perhaps Lockheed, no longer building C–5As, could devote all its resources to making repairs.[27]

Despite this eventual success, hammering out a contract had taken time and frayed tempers. In 1979 and 1980, the Air Force spent more than a year preparing a statement of work for the Phase IV wing installation contract, but Lockheed balked. The Air Force favored a firm fixed-price contract, an approach that, the service's procurement officials believed, would benefit both the company and the Air Force. Although special clauses would protect Lockheed from unforeseen economic and business setbacks throughout the multi-year program, the company showed no enthusiasm, obviously preferring a less stringent form of contract. As far as the Air Force was concerned, the wing problem had been the fault of the manufacturer, who had fabricated the wings with material that was much too thin and reduced the weight of this component without obtaining specific permission from the Air Force officials. Lockheed, however, argued that the company had acted in accordance with the weight requirement the Air Force had established for the aircraft. Having barely escaped bankruptcy, Lockheed was in no position to bargain. and in mid-1980 the company accepted the Air Force's terms.[28]

In the meantime, to make sure that Lockheed's reluctance to sign the multi-year contract would not delay the whole program, the Air Force gave Lockheed a short-term, though renewable, production contract worth $5.9 million. This agreement, issued on January 16, 1980, enabled Avco, Lockheed's subcontractor, to order the materials and parts it needed to begin making the wing boxes. Because the contract covered only three months and Lockheed continued to balk, the Air Force extended it for another three months, and finally renegotiated the agreement when the full production contract was awarded. On July 23, the long period of frustrating negotiations ended, as Lockheed finally signed the $68-million firm fixed-priced contract offered by the Air Force. This basic production contract covered fiscal 1980's increment of four sets of wings, with options for fiscal 1981 through 1984. The multi-year program reflected the assumption that all options would be exercised, which turned out to be the case. Avco began fabrication of the wing parts in August 1980, and machining operations for major wing panels commenced in September. Actually, the entire modification program progressed smoothly, and the 76th and last re-winged C–5A rejoined the operational fleet in mid-1987, as scheduled.[29]

Facing New Challenges

The protracted negotiation of the firm fixed-price re-winging contract demonstrated that contractors disliked this type of agreement; it certainly did not mean that the Air Force merely engaged in pointless haggling over a program in which it had lost interest. On the contrary, the Air Force and Department of Defense were willing to do anything within reason to speed the process. In the face of widespread political instability, American vital interests overseas seemed more vulnerable than ever, increasing the importance of aerial mobility.

Gen. David Jones, now the Chairman of the Joint Chiefs of Staff, warned that an emerging power vacuum in Southeast Asia demonstrated the global nature of American defense interests. As General Jones pointed out, American vital interests more often lay "close to the Soviet Union and far from us while they [the Soviets] have no truly vital interests far from them and close to us. So they have a geographic advantage, particularly in Southeast Asia." Similarly, the distant Persian Gulf was another potentially explosive area that could, at a moment's notice, require strategic airlift in quantity. The many logistical problems experienced in 1973, when Syria and Egypt attacked Israel, underscored the American concern about responding, except with long-range and air-refuelable aircraft, to a crisis generated by an oil-producing Arab state like Iran.[30]

The Air Force, to be sure, sought to solve the many problems presented by modern airlift in the late 1970s, but the effort encountered serious obstacles. These included: the reduction in C–5A procurement suggested in 1969 and approved the following year; the limitations of C–141As for long-range airlift until they were converted into B-models; and persisting dependence on the tactical C–130s, still effective but obviously aging. Another concern involved two related issues: cost versus money. The former appeared constantly growing, while the latter seemed perennially harder to get.

The issue of replacing the C–130 first surfaced when the turboprop tactical transport was still new. In 1963, as Project Forecast was recommending development of the CX Heavy Logistics Support Aircraft, which became the C–5A, the study also called for developing a vertical-short-takeoff-and-landing (VSTOL) aircraft to take the place of the C–130. The VSTOL project proved overly ambitious, however, and required technological innovations which, if theoretically possible, would require unrealistic outlays of money. In 1970, following Deputy Secretary of Defense David Packard's criticism of unnecessary features on the C–5A, the Air Force reduced the performance required of the VSTOL.

Scaling down the VSTOL's performance characteristics did not necessarily signal the end of the project. Also in 1970, the Air Force endorsed the Tactical Air Command's request for the "urgent development of a short-takeoff-and-landing (STOL) aircraft with greater payload and operational capability than the existing C–130." In accordance with Secretary Packard's policy of using prototypes to control weapons development costs, the Air Force Systems Command prepared proposals for an Advanced Medium STOL Transport (AMST). In 1973, Boeing and Douglas received contracts to build and test two prototypes each, but a lack of money would present an insurmountable obstacle. Although the U.S. Army and the Military Airlift Command backed procurement of the AMST, the escalation of costs, from $5 million per aircraft in 1970, to twice that much in 1977, and an estimate of $20 million by 1982, killed the production of either prototype.

The demise of the AMST in late 1979 did not surprise the Air Force. The high unit cost of the proposed transport prompted the decision, but shibboleth of cost-effectiveness played a part. The AMST, like the C–130, operated as an intratheater aircraft, but a new transport capable of both tactical and strategic airlift would be more cost-effective, and, in the opinion of MAC's leadership, have a better chance of acceptance in Washington when funds were scarce. Well aware of the fascination with cost-effectiveness, the Air Staff had been planning for several years to acquire just such an aircraft. The C–X, as this dual-purpose transport became known, would be larger than the C–141, but smaller than the C–5A. Although the C–X would retain many features of the defunct and expensive AMST, it would have to be comparatively cheap to develop and operate and also reliable and easy to maintain.[31]

Various factors sustained interest in the projected C–X. The stretched C–141 would

not be available before 1982, for example, and re-winging the C–5A wing would extend through mid-1987. Because the C–5A could not fulfill all future strategic airlift requirements, Air Force leaders in 1980 wanted the C–X contract to be awarded no later than August 1981, with the goal of reaching an initial operational capability with 16 aircraft in the fall of 1987, just after the last of the rebuilt C–5As entered service.[32]

President Ronald W. Reagan took office in January 1981, following a campaign that emphasized the need for increased military preparedness. Although aerial mobility did not head the list of the new President's priorities, Secretary of Defense Caspar W. Weinberger's explanations in presenting the President's rearmament requests to the House Military Appropriations Subcommittee on March 19, 1981, had to be especially encouraging for the Military Airlift Command. Weinberger favored procurement of the Advanced Tanker Cargo Aircraft, which became the KC–10, and the C–X transport.[33]

In the following months, some members of the House Appropriations Committee objected to the C–X program, favoring instead an existing wide-bodied aircraft such as the C–5, the DC–10 (precursor of the advanced tanker), or a modified Boeing 747. Before the end of 1981, however, the McDonnell-Douglas Corporation would receive a contract for the C–X, which became the C–17. Procurement of the C–5B, an improved version of the C–5A, also came under serious consideration; and Lockheed, in effect, reopened the C–5 assembly line, incorporating in the new version the modifications added to the original.[34]

The beginning of the 1980s thus started on a note of optimism for the Military Airlift Command, which had renewed confidence in the C–5A. Since 1970, after surviving severe Congressional and public criticism, along with engineering and financial crises, the C–5A demonstrated its remarkable usefulness, despite a flawed wing that resulted in stringent operating restrictions. The aircraft, moreover, was still in its infancy. No C–5A had accumulated as many as 8,000 hours of flying time against the new assured minimum total of 30,000 flying hours, made possible by the rebuilt wing. In short, because of the rebuilt wings, the C–5A's full potential was yet to be realized.

As time would show, the Air Force's confidence in the C–5A would prove be justified, in spite of some disappointments and a few failures. Early in 1980 Air Force Secretary Hans M. Mark reported that tests of a C–5A with the new wings showed that, contrary to expectation, the use of unimproved landing strips could seriously damage the aircraft. "I know that originally we thought C–5s should be able to do that but we were wrong," Secretary Mark admitted. The C–5's gigantic size also created problems at small hard-surfaced airfields which could not be used by other aircraft until a C–5A departed and made room. In late 1983, a re-winged C–5A presented difficulties in aerial refueling. Boom operators in the tails of KC–135 tankers experienced depth perception problems when refueling C–5As at night. The camouflage paint scheme on the C–5A made it difficult to judge the distance between the boom nozzle and the transport's flush-mounted fuel receptacle, even when using the tanker's floodlights. The use of wider camouflage stripes on the area from the C–5A's radome at the nose to the windscreen, and on the fuselage above the windscreen and around the fuel receptacle, solved the problem and led to a similar modification of the entire C–5A fleet.[35]

Whatever problems remained or might yet arise, the C–5A would continue to prove its worth. The fall of the Berlin Wall in November 1989 heralded the end of the Cold War—the collapse of communism in Eastern Europe and the Soviet Union. Nevertheless, airlift requirements would, if anything, increase because of potential threats to American security existing in Asia, the Middle East, and the Western Hemisphere.[36]

After several humanitarian airlift operations and a successful armed intervention in

Panama, American airlift, including the new C–5B, responded when Iraq on August 2, 1990, invaded neighboring Kuwait. This act of aggression prompted President George Bush to order an immense deployment to the Arabian peninsula to protect the Gulf states from further Iraqi aggression and liberate Kuwait. Under the code name of Desert Shield, the deployment began on August 7th. Desert Storm, the combat phase of the operation began in January 1991 and lasted until March 10, when an Iraqi defeat and the liberation of Kuwait ended the fighting.

From the start of the Iraqi invasion, it was apparent that the rapid arrival of land-based air power would be essential. Although aircraft carriers in the area had moved into position to deliver air strikes, their lack of long-range, high-capacity aerial tankers impeded the effectiveness of their squadrons. In these circumstances, airlift proved critical, for it could deliver troops and cargo within hours; sealift, with a far greater carrying capacity, would obviously take weeks if not months. Indeed, in a matter of only five days, C–5 and C–141 transports airlifted to Saudi-Arabia a brigade of the 82d Airborne Division, and the men and equipment needed to sustain five fighter squadrons, totalling 120 aircraft, and an AWACS contingent.[37]

Altogether, Desert Shield and Desert Storm required the services of 80 percent of the Air Force's C–141 fleet and 90 percent of the C–5s. These aircraft moved nearly three quarters of the air cargo and one third of the personnel airlifted into the Gulf region. Since the C–5's capacity by far exceed that of the C–141, the deployment afforded an impressive vindication of the often criticized C–5 Galaxy.

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CHAPTER VI

AN ASSESSMENT

The C–5A strategic transport, which became operational in 1970, fulfilled general airlift requirements that were a quarter of a century old, and in doing so helped bring together strategic and tactical airlift assets which, for various reasons, remained fragmented after World War II. Competing demands and unyielding budgetary constraints compelled the service to delay as long as it could the acquisition of a huge and costly strategic transport.

The basic requirements finally satisfied by the Lockheed C–5A were first identified back in 1945 by Theodore von Kármán, Director of the Army Air Forces Scientific Advisory Group. At that time, von Kármán told Henry H. Arnold, Commanding General of the Army Air Forces, that the aerial transportation of entire armies had to become a principal goal of the future Air Force. Although Arnold did not disagree, he was concentrating on the forthcoming independence of the Air Force and refused to allow a possible conflict over air transport to jeopardize that goal.

When the new Air Force became a reality in 1947, at least one element of von Kármán's dream of the future had to be deferred. The independent Air Force had scant enthusiasm for flying Army forces about the world, at least in part because the Army Air Forces had emphasized the decisive impact of strategic bombing to gain its new status. Facing increasingly dangerous foreign threats after World War II, the new Air Force prepared to defend the nation with its atomic strike force. When the bomber achieved intercontinental range, the United States adopted a strategy of deterrence through retaliation. The probable enemy, the Soviet Union, simultaneously made technological progress of its own, and by 1950 American atomic monopoly disappeared. Convinced that the Strategic Air Command, armed with nuclear weapons, could win a major war, the Air Force invested heavily in bombers and intercontinental ballistic missiles. In the process, strategic airlift for the most part supported SAC's strike forces.

Deterrence and retaliation formed the basis of national strategy throughout much of the Eisenhower administration. The administration of John F. Kennedy, who took office in January 1961, immediately endorsed a strategy of flexible response, which revived the concept of strategic airlift that von Karman had proposed. Flexible response required a fleet of transports that would enable the nation to react quickly to limited wars by moving conventionally armed military forces rapidly over great distances. The C–5A itself became embroiled in controversy, however, and had to overcome serious problems before succeeding as a long distance carrier of out-sized cargo. The C–5A proved costlier than initially expected, causing a reduction in the size of the program before the plane's achievements were fully appreciated.

The stagnation of post-World War II military airlift, finally corrected by the coming of the C–5A, reflected tradition and personalities. The Air Force emphasized combat aircraft over transports with a traditional consistency. Even the Army Air Service of the early 1920s thought primarily in terms of fleets of bombers, leaving the development and use of transports to the struggling airlines. World War II, however, cast a new light on the forgotten transports. Army leaders like Gen. Douglas MacArthur and Lt. Gen. George C. Kenney demonstrated in the Southwest Pacific that both strategic and tactical airlift could be crucial in waging wars over great distances. Nevertheless, bombing remained the raison d'etre of the Army Air Forces, resulting after the war in the air arm's emancipation from the Army and its emergence as an independent service. . . . . .

The Army Air Forces, after years of effort, gained its independence on September 18, 1947, but under the National Security Act, signed by President Harry Truman on July 26, 1947, numerous secondary functions and powers remained to be transferred before the new Air Force became the equal of the Army and Navy. Although the allocation of airlift assets had at best a secondary importance, former Secretary of the Navy James Forrestal, nominated by President Truman as the first Secretary of Defense, promptly tackled the problem of air transport. . . . . .

On June 1, 1948, Forrestal created the Military Air Transport Service (MATS), which absorbed both the Air Transport Command, the long-range air transport arm of the Army Air Forces, and the Naval Air Transport Service, the World War II long-range air transport arm of the U.S. Navy. Although operated by the Air Force, the Military Air Transport Service functioned until 1966 as the strategic airlift fleet of the new Department of Defense. Tactical airlift, including battlefield troop carrier activity, did not become a part of MATS.

The strategic airlift forces soon demonstrated their increasing importance as well as the worsening obsolescence of many of their aging transports, hastily acquired during World War II from manufacturers of commercial airliners. Within weeks of the creation of the Military Air Transport Service, the Soviet Union blockaded all land routes into Berlin. In response, the United States launched Operation Vittles, a large scale airlift orchestrated by Maj. Gen. William H. Tunner, well known for his wartime airlift successes.

For more than a year Operation Vittles operated around the clock and ensured the survival of the two- and-a-half-million people surrounded in the western sectors of Berlin. Vittles finally ended in August 1949, after airlifting more than two million tons of supplies, when Soviet authorities lifted the blockade. Success, though complete, was not easy, because the available transports—most of them Douglas C–54 Skymasters—were old and slow. Contrary to the expectations of airlift leaders, the Berlin operation did not result in the purchase of new transports. Procurement money remained scarce, and the shocking news in 1949 that the Soviet Union had detonated its first atomic device, reinforced the fiscal ascendence of the Strategic Air Command.

The confrontation between the Communist powers and the West erupted in violence on June 25, 1950, when troops of Communist North Korea invaded the Republic of Korea, an attack that could be interpreted as a first step toward world conquest by the Soviet Union and its proxies. To avoid the risk that the Korean fighting would escalate into a third world war, President Truman decided not to use atomic weapons in Korea, and instead to limit the conflict as America's European allies insisted. In short, the North Koreans, joined late in 1950 by the Communist Chinese, would be opposed under the auspices of the United Nations, even though the United States would provide most of the necessary forces. In keeping with his decision to wage a limited war, the President accepted the recommendations of the United Nations not to attempt to unify Korea, but to remain content to restore the territorial integrity of the Republic of Korea.

Despite the limited military objective of the United States, the Korean war lasted until July 27, 1953 before ending in a truce. The struggle provided the impetus to re-equip the Air Force with large quantities of new bombers, fighters, and fighter-interceptors, which, were rushed into production. Few of the new types incorporated any important technological advances so that, while numbers increased, most of these new aircraft would become obsolete shortly after the war. There was one exception, however, the Boeing B-47, a replacement for the Strategic Air Command's B-29s and B-50s. This jet-powered bomber included radically new features, but its short range prevented it from attacking distant targets without aerial refueling from bases overseas.

As for the airlift forces, despite their essential and often heroic performance throughout the Korean

conflict, their post-war status hardly improved. General Tunner faced a bleak situation in 1950 when he took command of all air transport and troop carrier operations in the Far East. Years of budgetary restrictions had prevented the Military Air Transport Service from modernizing the airlift fleet, and the training of pilots and maintenance crews proceeded sluggishly. Transport aircraft of the Far East Air Forces, already in the area when North Korea attacked, proved too old and too few. Tunner, as wartime commander in the combat theater, received some additional transports, mostly new twin-boom Fairchild C–119s that evolved from the Fairchild C–82. The C–119 impressed Tunner as being a good tactical aircraft, but being new it still exhibited some mechanical bugs. Despite these problems, the airlift organization managed to carry out such missions as the urgent deployment of troops, the dropping of paratroops, and the speedy delivery of tons of vitally needed cargo from Japan to Korea. . . . . .

Another mission, the life-saving aerial evacuation of casualties during the three-year war, required the help of the Civil Reserve Air Fleet. This new organization, consisting of about 350 commercial aircraft leased from the airlines, was initially formed in 1951 to assist the Military Air Transport Service in periods of crisis or conflict. However valuable the reserve fleet might prove, the use of an auxiliary pool of civilian airliners was bound to be costly.

The Korean conflict initiated a major defense build up. Although the new Eisenhower administration endorsed the maximum possible fiscal restraints, the arms race continued unabated after the war and dictated otherwise. At best, the President could try to get the biggest bang for the buck, which to him meant nuclear-armed bombers rather than conventional forces. Consequently, Air Force budgets, which increased significantly when the war broke out, kept on growing year after year. The bigger Air Force budgets, however, hardly helped the status of the military air transport, strategic or tactical. Only two new transports, the Douglas C–133 and the Lockheed tactical C–130, entered service between the end of the Korean conflict and the beginning of the 1960s.

General Tunner understood the power of nuclear weapons and the deterrent effect of the Air Force's strategic strike force, but he argued that the airlift mission remained important despite the continuing neglect of the transport aircraft. Even before the Korean conflict ended, Tunner openly criticized the scattering of transport assets among the Navy and Marine Corps as well as the various commands of the Air Force, all of which had different utilization standards that bred duplication and inefficiency. Being short of transports was bad enough, General Tunner bluntly declared, but wasting those available was inexcusable.

Once the Korean fighting ended, the Air Staff considered consolidating strategic air transports and tactical troop carriers, but gave up when both the Air Force's Tactical Air Command and the Army strongly objected. Troop carrier units, TAC argued, were combat units and their merger with a military airline into one air transport organization would combine combat operations with support or service functions, a combination judged unacceptable. Whereas the Korean conflict did not change the basic organization of transport aviation, it established its importance beyond challenge.

Shortly after the conflict ended in an armistice, Air Force Chief of Staff, Gen. Hoyt S. Vandenberg, declared that the Air Force logistics function should be as strategically mobile and flexible as the combat components it supported. Besides being costly, as Vandenberg observed, the alternative of prestocking supplies at overseas bases involved risk because, at the onset of war, an aggressor might deny the United States use of these very installations. At the same time that General Vandenberg stressed the importance of logistics and the necessity of ensuring strategic mobility and flexibility, the Army Chief of Staff, Gen. J.

Lawton Collins, began insisting that to meet world-wide threats the Army should become as air- transportable as possible, a demand that would be frequently repeated in the years to come. Neither Vandenberg nor Collins offered a new strategy based on aerial mobility; other leaders would later address that task.

The low priority of the airlift forces did not improve over the next few years. In truth, the Military Air Transport Service had no reason for optimism until July 1958, when General Tunner became commander—an assignment he had clearly earned and very much wanted. As he had during the Korean War, the new MATS commander faced a grim situation, this one including overseas crises that required the costly participation of numerous civilian airliners. Logically, this should have assured the command of more aircraft, but circumstances conspired against it. The American airline industry in 1958 was not making the profits it expected and feared that forthcoming jet-powered planes, plus the growing competition from foreign airlines, would worsen its financial plight. Since the airlines, according to Tunner[1], were already getting a quarter-billion dollars per year from the government for providing passenger service to military personnel and leasing aircraft to MATS, they viewed military air transport as a competitor and lobbied Congress to prevent its modernization, enlisting members of the press in the campaign. Tunner fought back, however, cultivating allies on Capitol Hill and in the nation's newsrooms.

Although the threat posed by the airline industry should not be underestimated, the gravest danger to the Military Air Transport Service came from the Eisenhower administration's defense policy of deterrence and massive retaliation, and its efforts to hold down taxes and balance the federal budget. Under these circumstances, Tunner believed that his command was being squeezed to death. Despite sizable budgets, the priorities that dictated Air Force procurement policy worked against airlift. Expensive though they were, nuclear bombs and the crews and aircraft to deliver them remained cheaper to maintain than a combination of nuclear and conventional forces, with the necessary air transport. Consequently, forces like airlift that seemed non-essential lost the annual battle of the budget. Even the Air Force's Tactical Air Command, a true war-fighting organization, enjoyed a lower priority than SAC. True, TAC could get money for fighters capable of dropping battlefield nuclear weapons, but its conventional forces underwent substantial reduction.

Cuts in the Tactical Air Command's conventional forces created additional problems for the Army, because both inter-service agreements and tradition required the ground forces to depend on TAC for airlift and air strikes in support of troops. Although the Army on several previous occasions had turned down closer coordination with the Air Force on airlift matters, General Tunner knew that the leaders of the late 1950s had changed their minds. Since Tunner could not alter Air Force policy, he sought outside allies; Army leaders stepped forward, and their timing could not have been better.

In January 1955 President Eisenhower acknowledged that certain contingencies might justify the use of mobile forces to help indigenous troops and protect American interests. At that time, the Army's strategy and force structure focused on a large-scale war, probably in Europe, and fought with nuclear weapons,[2] but the Army Chief of Staff, Gen. Maxwell D. Taylor, was drafting a non-nuclear strategy of flexible response that rapidly gained momentum. By 1958 the Army had embraced limited war concepts that required extensive help from strategic and tactical airlift. Tactical airlift could only be provided sparingly by the Tactical Air Command, now committed mainly to assist the Strategic Air Command in a general war or to function as an independent nuclear force in a limited conflict. For flexible response, the Military Air Transport Service had a fleet of more than 1,000 four-engine strategic transports, but the total combined military aircraft with commercial types from the

Civil Reserve Air Fleet. There were reasons for hope, however. After several hearings in late 1958 and early 1959, Congress resolved the airline industry's financial problems. Generous contracts to move military forces went to various airlines, provided they acquired modern cargo craft specifically earmarked for the Civil Reserve Air Fleet—an outcome that pleased General Tunner.

In 1959 the Air Force Chief of Staff, Gen. Thomas D. White, like his Vice Chief, Gen, Curtis E. LeMay, supported the administration's basic defense policy, including the possible use nuclear weapons to win limited conflicts. Yet, White had been instrumental in bringing the recent airline crisis to an end and had actually authorized General Tunner to argue the case for military airlift during the Congressional hearings. Under mounting pressure from supporters of flexible response, which enhanced the Army's role in limited conflicts and increased the importance of strategic airlift, the Air Force Chief of Staff again came to Tunner's assistance. In January 1959, White approved Tunner's plan to conduct a large-scale exercise of his command's capability to airlift a significant number of Army troops and equipment. General White may have privately doubted Tunner's ability to secure the Army's full participation, but just in case he did, the Air Force allocated funds to pay for the maneuver, though less than the amount Tunner requested.

Spartan funding did not deter General Tunner from moving quickly. Besides cultivating the friendship of Mendel Rivers, a powerful Congressman from South Carolina, Tunner worked closely with the Army Chief of Staff, Gen. Lyman L. Lemnitzer, and Gen. Bruce C. Clarke, who headed the Continental Army Command. General Tunner not only obtained the Army's full cooperation but, with the help of his very effective staff, planned the maneuver in record time.

Known as Operation Big Slam/Puerto Pine, the exercise began on March 14, 1960. The highly publicized two-week joint exercise airlifted 21,000 Army troops and 11,000 tons of cargo from various bases in the United States to Puerto Rico, an island less than a thousand miles from the mainland. Although the Air Force and Army personnel proved themselves, the transports of the Military Air Transport Service failed the test. In some 1,200 round trips, totalling more than 50,000 flying hours, the aging fleet of slow, short-range transports could deliver only 1,000 tons of cargo, including one light tank, a few other vehicles, and some artillery. Many of the Army troops, moreover, arrived without a single round of ammunition.

Big Slam/Puerto Pine demonstrated the pitiful performance of the available MATS transports, as Lemnitzer, Clarke, and Tunner intended. Almost all the reporters and Congressmen who had opposed MATS became ardent supporters of modernizing strategic airlift. The exercise clearly had a profound effect. In July 1960, the Congress appropriated, for the purchase or modification of long-range transports, $200 million more than the Air Force requested. Most important, these extra funds earmarked $50 million to begin development of the Lockheed C–141, which heralded a new era in airlift. With the tide running in favor of MATS, the Vice Chief of Staff, LeMay, an officer well known for his opposition to any change that might adversely affect the Strategic Air Command, did not challenge the C–141 program.

In 1961, following President John F. Kennedy's personal endorsement of both the strategy of flexible response and the quantity purchase of the Lockheed C–141, the Air Force began to think of another new, multi-purpose, long endurance aircraft to replace the spacious but mediocre Douglas C–133 turboprops. To that end, the Military Air Transport Service received in October a qualitative operational requirement issued by the Air Staff. The proposed replacement for the C–133 did not materialize in its initial form. In June 1962, the Army wanted no part of the proposed transport, then known as the CX-4, because it did not

represent any significant improvement over the forthcoming C–141. Secretary of Defense Robert S. McNamara, who from the start had questioned the cost effectiveness of a new force of large cargo aircraft, suggested that part of the money saved by giving up the CX-4 could be spent to stockpile equipment at depots overseas. The Army, though acknowledging the need for transports to carry out-size cargo like tanks, agreed with McNamara that pre-positioning and rapid sealift might be the best way to bring mechanized forces into an As General Vandenberg had emphasized after the Korean war, stockpiled supplies at bases overseas, besides being costly, might well invite the enemy to attack them directly or neutralize them through diplomatic pressure. From this point of view, McNamara's suggestion seemed both risky and inefficient. Strategic airlift afforded a better alternative which might, at least in part, pay for itself from the start by reducing dependence on costly leased aircraft. Moreover, a strong airlift force, deploying an air-transportable reserve from the United States, would reduce the number of American ground forces stationed overseas. This concept, tested in a recent exercise, led to the transfer of several fighter wings from Europe and Asia back to the United States, at substantial savings in the Air Force budget. LeMay, who replaced White as Chief of Staff in July 1961 expressed determination that the strategy of flexible response and the Army's growing role would not undermine the importance of the Air Force. In the fall of 1963 he linked the Air Force and its modernized airlift to flexible response and publicly acknowledged that the country's powerful nuclear forces ". . . cannot by themselves deter limited war or protect U.S. interests when limited war occurs." For him, strategic airlift had become an essential element of national defense.[3]

Actually, General LeMay's public announcement of the shift in policy to support a build-up in strategic airlift forces followed closely completion in April 1963 of a classified Air Force study, Project Forecast. This series of reports covered new, highly sophisticated weapon systems for both the near term and distant future and made a favorable impression on LeMay. The list of new weapon systems included a heavy logistics transport aircraft far more advanced than any ever suggested by the Army. The anticipated characteristics of the new transport would solve the dilemma faced by Air Force and Army leaders following the Army's rejection of the CX-4 project. Moreover, the technological advances of the Forecast transport, which would stay in the operational inventory for several decades, made the new project very attractive. It would be cost effective and therefore likely to secure Secretary McNamara's approval more easily than the ill-fated CX-4. . . . . .

After being designated successively as the CX-X and CX-HLS, the Forecast transport, supported by General LeMay, was approved in December 1964 by Secretary McNamara, who redesignated it the C–5A. Although McNamara favored acquisition of the Lockheed C–5A, he insisted on carefully controlling costs. Unless the C–5A attained an initial operational capability in 1969, he proposed to adopt a more cost- effective course of action and buy an improved version of the C–141 instead. The Air Staff, however, accelerated the procurement process to ensure that McNamara's deadline would somehow be met.

In the ensuing years, whether under the leadership of General LeMay or Gen. John P. McConnell, who became the Air Force Chief of Staff in February 1965, or General John D. Ryan, who took over in August 1969, the Air Force's interest in the C–5A program never faltered. The service continuously sought to make sure that the C–5A's problems as well as those of its contractor would not be allowed to destroy the program. The Air Force attitude in part reflected a fear that Army aviation, which already included a hundred twin-turboprop transports comparable in size to the C–47 of World War II, would somehow lay claim to at least a share of strategic airlift.

The Air Force had other reasons during the late 1950s and early 1960s to nurture the

costly C–5A program. In 1960, Deputy Secretary of Defense James H. Douglas, aware of the increasing Congressional interest in meeting the threat of limited war, recommended that force structure be based on the possibility of limited war. Although the Air Force emphatically rejected Secretary Douglas's suggestion, as did the Department of Defense, the Air Force in general and LeMay in particular believed that the emphasis on limited war might yet prevail. Official endorsement of the flexible response strategy in early 1961 hardly alleviated General LeMay's concern. In the spring of 1962, when Secretary of Defense McNamara directed a review of the Army's tactical mobility requirements, the Air Force became convinced that the Army planned to acquire an expanded air arm of its own, comparable to the old Army Air Corps. Moreover, should the Army remain dissatisfied with the Air Force's airlift policies, a revived Air Corps might provide the means of taking over strategic airlift.

General LeMay, like other leaders before him, recognized that playing ball with an ambitious opponent could provide the best way of sidetracking the threat. LeMay already realized that overseas crises were bound to occur and that the nation in future decades would unavoidably have to fight limited wars. Although he sometimes vigorously emphasized the importance of airlift to national defense, for example endorsing Tunner's views in early 1960, the Air Force and LeMay still relegated airlift forces to the status of poor relations and remained content to postpone indefinitely the restructuring of the Military Air Transport Service. General Tunner argued that his command should be reorganized as the Military Airlift Command (MAC), with greater emphasis on military operations, expanded use of airlift by all agencies of the Defense Department, and adequate representation for all three services on its staff. Tunner's recommendations fell on deaf ears, however, and reorganization of the Military Air Transport Service was deferred for several more years.

MATS became the Military Airlift Command on January 1, 1966, following the increasing commitment of U.S. forces to Southeast Asia and the immediate acceleration of strategic airlift programs. The production rate of the Lockheed C–141 increased, the Air Force received large-scale deliveries of C–141s in 1966, and 14 squadrons of the new aircraft became operational in 1967.

Lockheed's production of the larger C–5A did not fare as well as the C–141 program. Despite the firm's efforts, the C–5A's initial operational capability, scheduled for 1969, slipped significantly, and the much-needed large cargo plane did not reach South Vietnam in a truly operational capacity until August 1971. In the months that followed its debut, the aircraft played a major role in strategic airlift to Southeast Asia. Yet, the C–5A's spectacular post-Vietnam accomplishments dramatized the importance of strategic airlift and, therefore, facilitated the Military Airlift Command's eventual ascent to the status of a specified command.

This is not to say that the Vietnam War did not affect significantly the future of both the strategic and tactical airlift forces. From the start, the conflict altered the existing doctrinal and institutional underpinnings of airlift policy. As the war progressed, it confirmed the logic of a consolidated airlift organization with the status of a combat command, a change finally supported by influential leaders of the Tactical Air Command and of the airlift organizations in overseas theaters. The change of opinion among these leaders—believed fully justified by the wartime activities of all types of airlift operations, whether tactical, strategic, or battlefield—reflected a critical institutional readjustment.

To begin with, the Vietnam war caused MAC, TAC, and Army Aviation airlift organizations to expand substantially their mission responsibilities and capabilities. The rise of Army Aviation was meteoric,[4] a ten-fold increase in helicopters and fixed-wing aircraft over

seven years. Individual field commanders retained operational control of the Army assets even though in March 1966 the 1st Aviation Brigade had been activated to manage the logistics and training standards of Army Aviation units in Vietnam. The management and command structures conformed with Army doctrine and seemed to indicate that the Army was not truly thinking of reacquiring an air arm of its own. Still, Army Aviation's growing importance in Vietnam remained of concern to the Air Force, for the Army's battlefield airlift, like its Air Force counterpart, increased in technological sophistication and capability.

Whereas the Military Airlift Command did not expand as dramatically as Army Aviation, MAC's wartime contributions were impressive. Despite a limited number of new C–141 strategic transports, their speed enabled one of them to deliver more cargo than four of the aging Douglas C–124 Globemasters during a given period of time. The C–130s of the Air Force tactical airlift units, however, served as the mainstays of intratheater mobility operations and for much of the
routine logistics effort within Southeast Asia.

The Air Force's strategic and tactical airlift successes during the Vietnam conflict did not by themselves account for the consolidation of these forces. The Air Force's perception that the Army still intended to rebuild its own Air Corps and the efforts to counter any such project may have speeded the 1974 consolidation of its airlift assets, ironically so since in April 1966 General McConnell, the Air Force new Chief of Staff, had signed an agreement with the Army Chief of Staff, Harold K. Johnson, that in effect yielded any claim to the Army's helicopters in exchange for the Army's large fixed-wing transports. Despite Air Force doctrine that air units must remain under the centralized control of airmen, McConnell and Johnson agreed that in cases of operational need, Air Force aircraft performing supply, or troop-lift functions in the area of a field army, could be attached to, and therefore controlled by, the subordinate tactical echelons of the field army.

By the end of the Vietnam War many other indications appeared suggesting that changes affecting strategic and tactical airlift forces were all but inevitable. In August 1967 the Tactical Air Command's troop carrier wings were redesignated tactical airlift wings, a change that implicitly suggested, but did not establish, a linkage with the military airlift wings of the newly-established Military Airlift Command. Another example that strategic and tactical airlift forces could be consolidated effectively arose from the formation in October 1966 of the 834th Air Division, which controlled all theater airlift and airlift support operations in South Vietnam. By early 1969, the Air Division commander could order the strategic C–141 transports to perform extra intratheater sorties in support of the local airlift effort. The increasing use of MAC transports in tactical airlift operations demonstrated that treating the strategic airlift forces as an airline rather than a combat force had become unrealistic.

In the meantime, however, the Air Force as well as the other military services clung to their traditions and fiercely defended their individual turf. The advent of the Military Airlift Command ended a partnership between the Air Force and Navy that began in 1948 when the Air Transport Command and the Naval Air Transport Service merged to create MATS. When on February 1, 1977, MAC emerged as a specified command, equal in status and authority to any other Air Force combat command, the Navy and Marine Corps managed to retain a small independent portion of their individual transport fleet.

Over the years, the Air Force had moved warily toward changing the status of airlift. Following the long delayed creation of the Military Air Command, Air Force Manual 2-4, *Tactical Airlift*, and Air Force Manual 2-21, *Strategic Airlift*, drew a careful distinction the two missions and forces. As time passed, the Air Force ensured stagnation of airlift policy by

retaining the same division in the governing doctrinal publications. The operational record of the Vietnam War persuaded the Air Force in mid-1972 to revise Air Force Manual 2-21, but the revision sharpened the organizational distinction between strategic and tactical airlift. The new manual, however, accepted its predecessor's provisions for transferring temporary control of one airlift force to the commander of another, thus acknowledging that new airlift aircraft like the C–141, and operational experience with them, made such transfers acceptable. The revision, by endorsing the use of strategic airlift on missions within a theater, also confirmed that consolidation of airlift forces was out of the question, at least for the near future, since the Air Force did not intend to alter existing organizational arrangements.

Though the air transport forces had definitely grown in importance as well as capability since 1960, advocates of airlift kept a low profile, believing that emphasizing the accrual of minor gains might jeopardize a future breakthrough. The days of General Tunner were gone, and the post-Vietnam War period proved an inopportune time to find support for consolidation of the airlift forces. In late 1972 budgets were tight, the public had little sympathy for military spending, and the President and Congress faced serious problems, including not only ending the Vietnam conflict but other possible crises in the Middle East and elsewhere.

The war against Israel, initiated by Egypt and Syria in October 1973, dramatized the importance of the C–5A. Restrictions on U.S. landing rights and overflights during the conflict—in part a result of a threatened refusal by oil-producing Arab states to supply nations supporting Israel—underscored the importance of global mobility as well as the unique contribution of the long-range C–5A. MAC overcame the restrictions on routes and refueling bases to provide a constant flow of supplies that helped Israel prevail. This success and the emergence of a new generation of Air Force leaders combined to help bring about the subsequent designation of MAC as a specified command future status.

Of course, the Air Force had strong backing from the Department of Defense in eventually making this change. Early in 1974, Secretary of Defense James R. Schlesinger described the global mobility of American military forces as being essential to deter future conventional wars. In August of that year Gen. David Jones, the new Air Force Chief of Staff, decided to combine all the service's airlift, strategic and tactical, in the Military Airlift Command. Meanwhile, Gen. Paul Carlton, MAC's commander since 1973 and already known for his progressive ideas, outlined for the Congress his command's problems and suggested this unification as means to improve future airlift operations. Nonetheless, in 1977, when MAC finally became a specified command, many in the Air Force still questioned the wisdom of the decision. Even after the war against Iraq, when the C–5 fleet again made outstanding contributions, numerous high-ranking Air Force officers, commanders of so-called true combat commands in particular, continued to resent the ascendence of the airlift forces, perhaps thinking how many new fighters might be bought for the price of a single C–5 transport.

Endnotes

1. William H. Tunner, *Over the Hump* (Washington, D.C.: Office of Air Force History, reprint 1985), pp. 290-91.
2. Robert Charles Owen, *Creating Global Airlift in the United States Air Force, 1945-1947: The Relationship of Power, Doctrine, and Policy* (Department of History, Duke University, dissertation, 1992), pp. 195-247.
3. *Ibid*., pp. 302-11.
4. *Ibid*., pp. 345-84.

APPENDICES

APPENDIX 1

ESTIMATED MISSION PERFORMANCE BASED ON CONTRACTOR REVISED PROPOSALS OF SEPTEMBER 4, 1965.

LONG-RANGE MISSION

	Required	Boeing	Douglas	Lockheed
Takeoff distance (ft)	8,000	7,350	8,000	
Landing Distance (ft)	4,000	3,460	3,620	3,700
Range (n.m.)	5,500	5,125	5,747	
Payload (lb)	100,000	100,000	100,000	100,000
Cruise Speed (kn)	440	446	440	440
Rate of Climb (fpm)	400	400	440	480
Takeoff Weight (lb)	--	665,000	666,700	712,000
Load Factor	2.5	2.5	2.5	2.5

SHORT-RANGE MISSION.

	Required	Boeing	Douglas	Lockheed
Takeoff Distance (ft)	8,000	8,000	7,350	8,000
Landing Distance (ft)	--	4,040	4,270	4,340
Range (nm)	2,700	2,775	2,605	3,278
Payload (lb)	200,000	200,000	200,000	200,000
Cruise Speed (kn)	440	470	440	440
Rate of Climb (fpm)	400	400	440	470
Takeoff Weight (lb)	--	665,000	666,700	712,000
Load Factor	2.5	2.5	2.5	2.5+

OVERLOAD MISSION.

	Required	Boeing	Douglas	Lockheed
Takeoff Distance (ft)	10,000	9,930	8,800	9,700
Landing Distance (ft)	--	4,440	4,620	4,780
Range (nm)	2,500	2,569	2,391	2,831
Payload (lb)	265,000	265,000	250,000	265,000
Cruise Speed (kn)	440	440	440	440
Rate of Climb (fpm)	100	150	300	340

Takeoff Weight (lb)	--	725,000	716,700	769,000
Load Factor	2.25	2.25	2.25	2.25

Abbreviations.

fpm	feet per minute.
kn	knots.
nm	nautical miles.
lb	pounds.

LANDING PERFORMANCE.

1,000-Nautical-Mile Flyback Mission Without Refueling.

	Required	Boeing	Douglas	Lockheed
Landing Distance (ft) or 4,000 or 4,000	4,000	3,650 or 4,000	3,790 or 4,000	3,860 or 4,000
Payload (lb)	100,000	100,000 or 167,000	100,000 or 132,000	100,000 or 123,000

2,500-Nautical-Mile Flyback Mission Without Refueling.

	Required	Boeing	Douglas	Lockheed
Landing Distance (ft)	4,000	3,920 or 4,000	4,120 or 4,000	4,190 or 4,000
Payload (lb)	100,000	100,000 or 120,000	100,000 or 82,000	100,000 or 72,000

Abbreviations

fpm = feet per minute
kn = knots
nm = nautical miles
lb = pounds

SOURCE: History, Aeronautical Systems Division
July 1965-June 1966, Volume I, pp. 109-110.

APPENDIX 2.

C–5A PROGRAM FUNDING.

R&D Funding by Fiscal Years*.
(In dollars)

Fiscal Year	Appropriated	Committed	Obligated	Expended
1966	158,866,000	158,854,477	158,854,447	158,842,613
1967	278,653,555	278,562,597	278,562,597	278,552,044
1968	341,900,000	341,743,934	340,639,978	314,636,457
1969	126,000,000	124,514,816	123,722,867	55,899,555
1970	34,200,000	25,031,321	21,304,771	18,728,063
Total*	939,619,555	928,707,115	923,084,660	826,658,732

*/ Excluding $52 million used to fund the program definition phase.

Production Funding by Fiscal Years.
(In dollars)

Fiscal Year	Appropriated	Committed	Obligated	Expended
1967	388,400,000	387,251,002	385,600,654	383,599,038
1968	440,000,000	423,614,715	417,668,687	394,467,938
1969	494,000,000	452,345,508	443,688,393	414,106,111
1970	481,000,000	372,621,702	371,477,071	296,246,831
1970**	225,000,000	225,000,000	225,000,000	218,385,944
Total	2,028,400,000	1,860,832,927	1,843,434,805	1,706,805,862

**/ These funds were expected to cover amounts over the Production Run A's target costs. The same rationale accounted for the extra $34.2 million of R&D funds appropriated in Fiscal Year 1970.

SOURCE: History, Aeronautical Systems Division, July 1969-June 1970, Volume I, p. 209.

APPENDIX 3

LOCKHEED SUPPLEMENTAL AGREEMENT 1000,

MAY 31, 1970.

The agreement replaced the basic C–5A total package procurement contract, AF 33 (657) 15053, of October 11, 1965, as amended through May 31, 1970. Under the terms of the new contract, restructured by Supplemental Agreement 1000, the Lockheed-Georgia Company agreed to:

1. Waive all existing claims as well as rights to performance incentive payments.

2. Give up any "profit or fee for spare parts and other provisioned items to be supplied."

3. Accept "extraordinary mangement controls" by the government.

Supplemental Agreement 1000 also nullified and, therefore, removed from the contractor's purview a number of provisions that had been part of the basic total package procurement contract.
Included in such provisions were:

1. Total system performance responsibility.

2. Pricing of changes.

3. Repricing.

4. Adjustment for economic fluctuations.

GENERAL ELECTRIC'S RESTRUCTURED CONTRACT,

SEPTEMBER 15, 1970.

The restructured engine contract of September 15, 1970, superseded the General Electric Company's total package procurement contract, AF 33 (657) 15003, of October 1965, but retained the number of engines--228-- contracted for to equip the first aircraft purchase (the 58 C–5A aircraft of Production Run A). The new contract, however, decreased the second purchase of engines from 279 to 176 to match the reduced acquisition of Run B C–5A aircraft (decreased from 57 to 23), bringing total engine procurement to 404 against a grand total of 81 C–5As.

The General Electric contract of 1970 established an 85-15 percent sharing arrangement between the government and the contractor, with a target price of $665.9 million.

	Target Cost	Target Profit	Ceiling Profit	Estimated Price	Estimated Profit
Government Interpretation	$602.6	$60.6	$766,2	$766.2	$18.8
General Electric Interpretation	$696.7	$60.6	$909.8	$804.8	$50.4
Settlement	$609.8	$56.1	$802.6	$785.6	$35.0

The new G.E. contract was patterned on the Lockheed C–5A contract restructured by Supplemental Agreement 1000. As a result, the basic engine contract's controversial provisions were eliminated as were clauses that might lead to extensive litigation. The provisions and clauses left out of the new contract included:

1. Abnormal fluctuations in the economy.

2. Repricing formula.

3. Changes in the contractor's cost share.

4. Adjustment for changes in the law.

SOURCE: History, Aeronautical Systems Division
July 1970-June 1971, Volume 1, pp. 121-125.

APPENDIX 4

THE C–5A YEARLY PRODUCTION AND STATUS.

Fiscal Year	Testing		Operational	Total
	Category I	Category II		
1968	1	-	-	1
1969 */	3	1	-	4
1970	1	2	8	11
1971	-	-	27	27
1972	-	-	19	19
1973 **/	-	-	19	19
	5	3	73	81

*/ Justifying the concern that Lockheed might cancel the aircraft production, the Air Force by mid-1969 had given $1.52 billion to the contractor but had acquired only four C–5As.

**/ A subcontractor strike caused Lockheed to delay delivery of the last C–5A from February 1973 to May 1973.

Reduction of production rates and accompanying delivery slowdown affected the C–5A program on several occasions. In 1969, when the program was under review and money was short, the Air Force decreased Lockheed monthly C–5A production rate from 4 to 3. The decision at the time was expected to postpone the end of production to June 1972.

In February 1970, claiming that it could not survive otherwise, Lockheed asked and was authorized to reduce the C–5A monthly production from 3 to 2. This would delay the end of production to February 1973. To the Air Force's relief, the final slippage proved to be short and did not extend beyond May 1973.

SOURCE: History, Aeronautical Systems Division, July 1971-June 1972, Volume I, p. 86.

APPENDIX 5.

DOD Directive 5160.2, "Single Manager
for Airlift Service," 7 December 1956.

- Designated the Secretary of the Air Force as the Single Manager for Airlift Service.

- Integrated all scheduled airlift under MATS as the Single Operating Agency for Airlift Service.

- Directed that most of the Tactical Air Command's (TAC) and the Navy's heavy airlift assets be transferred to MATS.

- Allowed for MATS' retention of the technical services (air photographic, air rescue, air communications, air weather, and flight service), if desired.

- Provided for the establishment of what became in 1958 the Airlift Service Industrial Fund (ASIF).

- Required MATS to contract with the commercial carriers for airlift in peacetime to ensure their economic development and availability during war. Directed the development of an expanded mobilization base through the "maximum feasible" use of civil airlift--in other words, the Civil Reserve Air Fleet program.

DOD Directive 5160.22, "Clarification of Roles and Missions of the Departments of the Army and the Air Force Regarding the Use of Aircraft," 18 March 1957.

- Restated USAF mission of providing airlift support to Army to include airlift of personnel, supplies, and equipment to, from, and within the combat area.

- Restricted Air Force aeromedical airlift to from the combat area to outside hospitals.

- Prohibited the Army from procuring strategic and tactical airlift aircraft, although Army could own aircraft for command liaison, communications, observation, reconnaissance, fire adjustment, survey and small-scale airlift requirements within the combat zone.

SOURCE: HQ AMC/HO/Betty R. Kennedy, GS 12/5754/6 Aug 93, p.4.

APPENDIX 6.

MAC AIRLIFT MISSIONS AND FLYING HOURS
1965-1985

Year	Missions	Flying Hours
1965	719	39,234
1966	520	31,958
1967	405	24,397
1968	390	21,308
1969	235	9,170*
1970	323	7,566
1971	341	6,075
1972	320	6,655

1973 . . . . . .
. . . . . .
319 . . . . . .
. . . . . .
4,485
1974 . . . . . .
. . . . . .
382 . . . . . .
. . . . . .
4,470
1975 . . . . . .
. . . . . .
307 . . . . . .
. . . . . .
3,512
1976 . . . . . .
. . . . . .
166 . . . . . .
. . . . . .
3,291
1977 . . . . . .
. . . . . .
139 . . . . . .
. . . . . .
3,124
1978 . . . . . .
. . . . . .
207 . . . . . .
. . . . . .
4,860
1979 . . . . . .
. . . . . .
154 . . . . . .
. . . . . .
3,216
1980 . . . . . .
. . . . . .
143 . . . . . .
. . . . . .
3,528
1981 . . . . . .
. . . . . .
96 . . . . . .
. . . . . .
2,440
1982 . . . . . .
. . . . . .
123 . . . . . .
. . . . . .
3,277.5
1983 . . . . . .

	122
	3,349.3
1984	
	105
	3,279.1
1985	
	123
	3,827.5

*The sharp decline in flying hours starting with 1969 may have been the result of greater use of jet aircraft, particularly the C-141, to transport nuclear cargo.

SOURCE: Rprts (U), MAC DCS Ops/DOOMS/Nuclear Airlift Section, "Mission Summaries," 1965-1984; "Mission/Sortie Summary--1985;" and "Flying Hour Summaries," 1965-1985.

APPENDIX 7.

THE COST AND REPRICING FORMULAE INSERTED IN THE LOCKHEED CONTRACT.

The Lockheed contract provided that the government would assume 70 percent of cost overruns up to 130 percent of the target cost. If the target cost were $1 million, the target profit would be $100,000 (10% x $1 million), and the target price for the government would be $1 million + $100,000 = $1.1 million. If the actual cost proved to be $900,000 (an underrun), then Lockheed's profit would be $100,000 + 30% x ($1 million - $900,000) + $100,000 + $30,000 = $130,000. If the actual cost proved to be $1.1 million (an overrun), then Lockheed's profit would be $100,000 - 30% x ($1.1 million - $1 million) = $100,000 - $30,000 = $70, 000.

If the actual cost of the plane proved to be $1.310 million, then Lockheed's profit would be zero, since Lockheed would assume 30% of he overrun up to $1.3 miilion (130% x $1 million) and 100% of everything over that: Profit = $100,000 - 30% x ($1.3 million - $1 million) - 100% x ($1.310 million - $1.3 million) = $100,000 - $90,000 - $10,000 = 0. If the actual cost exceeded $1.310 million, Lockheed would lose money.

The repricing formula was designed to limit the amount of money Lockheed would lose. Assume a target cost for Production Run A of $831.9 million (therefore a target price of 10% more or $915.1 million) but an actual cost of $1,425.9 million, so that Lockheed is losing $419.3 milion on Run A. However, the 130% cost ceiling for Run A has been exceeded, triggering the repricing formula. Assume a Production Run B target cost of $489.9 million:

1)Actual Cost Run A/Target Cost Run A - Run A Ceiling % = % Variance
or $1,425.9 million/$831.9 million - 130% = % Variance
and % Variance + 41.4%

2)(% Variance x 2) + 100% = Target Cost . . . . . Adjustment Factor (TCAF)
TCAF = (41.4% x 2) + 100%
= 182.8%

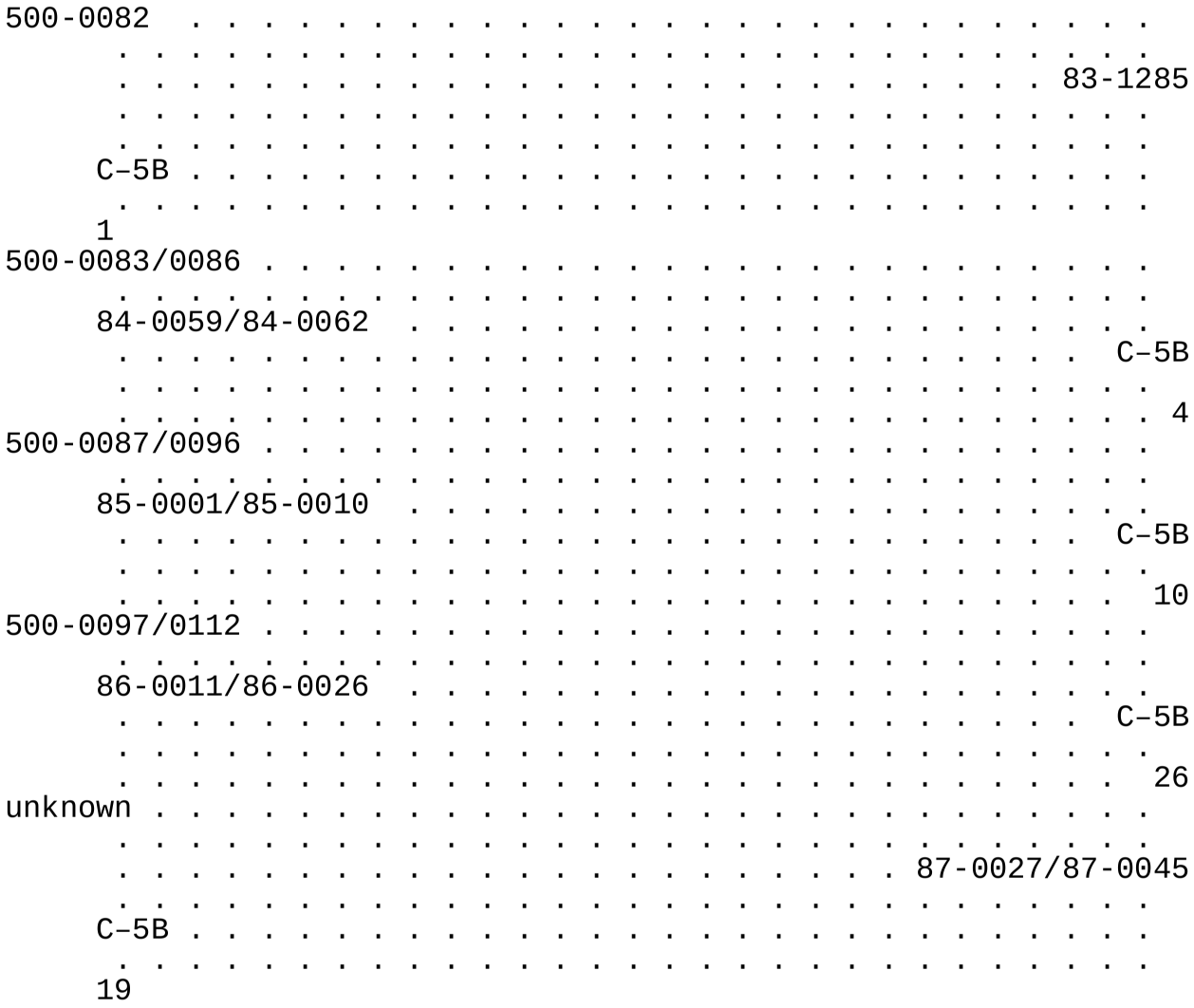
3)TCAF x Run B Target Cost = New Run B Target Cost
182.8% x $489.9 million = $895.5 million

4)New Run B Target Cost x 130% = New Run B Ceiling
$895.5 million x 130% = $1,164.2 million

Appendix 8.

Lockheed Aircraft Corporation Numbers and Air Force Serial Numbers

LAC Numbers	AF Serial Numbers	Model	Quantity
500-0001/0005	66-8303/66-8307	C–5A	5
500-0006/0013	67-0167/67-0174	C–5A	8
500-0014/0031	68-0211/68-0228	C–5A	18
500-0032/0058	69-0001/69-0027	C–5A	27
500-0059/0081	70-0445/70-0467	C–5A	23



C–5 Acceptances 1969-1989

Model	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
C–5A	5	20	24	19	10	1	1														
Rewinging								1		14	18	17	17	9							
C–5B									1	8	13	23	5								

C–5 Attritions

Date	Serial No.	Unit	Locations	Primary Cause
May 25, 1970	67-0172	AFFTC	Edwards AFB, CA	Ground Fire
Oct. 17, 1970	66-8303	Lockheed	Marietta, GA	Ground Fire
Sep. 27, 1974	68-0227	443d MAW	Altus AFB, OK	Ground Fire
Apr. 4, 1975	68-0218	60th MAW	Nr Saigon, Vietnam	Improper maintenance; aft door complex blew out damaging control and hydraulic lines
Aug. 29 '90	68-0228	349th MAW (Assoc.)	Ramstein AB, Germany	Not determined

* Source: Rene Francillion, "Galaxy, Mighty Lifter," *Air International*, (November 1944), pp. 269-271. Reprinted by permission.

BIBLIOGRAPHIC NOTE

A few of the many records and books consulted in writing this volume deserve special mention. Michael Gorn's *Vulcan's Forge: The Making of an Air Force Command for Weapons Acquisition, 1950-1985* proved extremely valuable as did the histories and studies prepared by Michael Levy and the other historians of the Aeronautical Systems Division of what was then the Air Force Systems Command. Robert Frank Futrell's *Ideas, Concepts, and Doctrine: Basic Thinking in the United States Air Force, 1907-1984* lived up to its ambitious title. Other essential works included *Buying Aircraft: Materiel Procurement for the Army Air Forces* by Irving Brinton Holley, Jr.; *Arming America: How the U. S. Buys Weapons* by J. Ronald Fox; and "Creating Global Airlift in the United States Air Force, 1945-1977: The Relationship of Power, Doctrine, and Policy," a doctoral dissertation that Robert Charles Owen submitted to the Department of History, Duke University, in 1992.

Abbreviations

ADO	Advanced Development Objective
AFB	Air Force Base
AFLC	Air Force Logistics Command
AFSC	Air Force Systems Command
AMC	Air Materiel Command
AMST	Advanced Medium STOL Transport
ARDC	Air Research and Development Command
ASD	Aeronautical Systems Division
ASPR	Armed Services Procurement Regulation
ATCA	Advanced Tanker Cargo Aircraft
CPFF	Cost-Plus-Fixed-Fee
CPPC	Cost-Plus-Percentage-of-Cost
CRAF	Civil Reserve Air Fleet
CX-HLS	Cargo, Experimental—Heavy Logistics System
DCS	Deputy Chief of Staff
DEW	Distant Early Warning
DOD	Department of Defense
FEAF	Far East Air Forces
FPIF	Fixed-Price-Incentive-Fee
GAO	General Accounting Office
ICBM	Intercontinental Ballistic Missile
IOC	Initial Operational Capability
IRF	Inflight Refueling
MAC	Military Airlift Command
MATS	Military Air Transport Service
MTOW	Maximum Takeoff Weight
NASA	National Aeronautics and Space Administration
QOR	Qualitative Operational Requirement
RAND	Research and Development Corporation
R&D	Research and Development
RDC	Research and Development Command
RFC	Reconstruction Finance Corporation
RFP	Request for Proposals
SAC	Strategic Air Command

SAM	Surface-to-Air Missile
SEC	Securities and Exchange Commission
SOR	Specific Operational Requirement
STOL	Short Takeoff and Landing
STRAC	Strategic Army Corps
STRICOM	U.S. Strike Command
TAC	Tactical Air Command
TADJET	Transport, Airdrop, and Jettison
TFX	Tactical Fighter, Experimental
TPPC	Total-Package Procurement Concept
UN	United Nations
USSR	Union of Soviet Socialist Republics
VTOL	Vertical Takeoff and Landing
WRM	War Readiness Materiel