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OPERATION DESERT STORM

An Assessment of Aerial Refueling Operational Efficiency

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The Honorable Sam Nunn
Chairman, Committee on Armed Services
United States Senate

The Honorable John Warner
United States Senate

This is our second report in response to your request that we assess the future of the air refueling tanker force in light of Operation Desert Storm and the significant changes in the international security environment. Our earlier report[1] pointed out that Desert Storm had underscored the relevance of a 1990 initiative intended both to (1) enhance the efficiency of the tanker force during conventional combat and (2) standardize the refueling systems of U.S. fighter aircraft. This report focuses on additional actions that the Desert Storm experience suggests could further improve the efficiency and effectiveness of aerial refueling operations.

Results in Brief

A large coalition tanker fleet transferred over 700 million pounds of fuel during roughly 50,000 refuelings to about 2,000 aircraft over the 43 days of combat. While these overall results suggest a notable success story, it must also be acknowledged that an average of almost 40 percent of the fuel carried by Air Force tankers went unused. Unused fuel is an indication of the inefficiency of tanker operations—that is, the match between the fuel available aboard tankers and the fuel actually required by receiver aircraft. This degree of inefficiency prevented additional combat missions from being supported, a frustrating situation for operational planners. It also suggests that more tankers were supporting operations than were needed based on fuel requirements alone.

The pre-Desert Storm priority of refueling strategic bombers left a gap in both the capability and knowledge necessary to support a large conventional contingency. Accordingly, the tanker force faces a number of challenges as it transitions to a predominately conventional role. A major question facing the Department of Defense (DOD) is determining, in light of the smaller post-Cold War force, the proper size and capability of the tanker fleet. While Desert Storm may not be a prototype for future tanker

[1]Aerial Refueling Initiative: Cross Service Analysis Needed to Determine Best Approach (GAO/NSIAD-93-186, July 19, 1993).

operations, it offers lessons learned that are relevant to answering this question.

These lessons include the need for better planning tools and communication equipment; more research and analysis of methods to provide air refueling support; better integration of tankers into exercises and planning for conventional contingencies; a more equitable sharing of tanker training hours among receiver communities; and greater standardization of refueling systems. Complicating the application of these lessons is the fact that the Air Force does not collect and analyze data on unused fuel. We believe that the availability of such data is critical to improving the efficiency of aerial refueling operations.

Background

The primary role of the approximately 600 jet tankers managed by the Air Force is to support operations by U.S.-based strategic bombers. That role emphasizes preplanned missions in which each tanker provides a large and predictable amount of fuel over great distances to one of several hundred strategic bombers. A secondary tanker role is to support the deployment and employment of aircraft during a conventional conflict. As documented by Desert Storm, conventional operations are far more complex and difficult to support because of shorter planning periods, rapidly changing priorities, crowded airspace, less predictable fuel requirements, lack of standardized refueling equipment, and continuous operations by thousands of aircraft.

In all, nearly 300 U.S. tankers and an estimated 40 from the United Kingdom, Saudi Arabia, Canada, and France provided refueling support to fighters and other aircraft during combat operations—a ratio of about one tanker for every six receivers. The U.S. total included 260 Air Force KC-135/KC-10 model tankers,[2] 20 Marine Corps KC-130 tankers, and 15 carrier-based Navy KA-6 tankers. Both the Marine Corps and Navy must rely on the Air Force if extensive tanker support is required. Air Force tankers supporting combat operations during Desert Storm represented about 40 percent of Air Force tanker assets. Coalition tankers operated from more than a dozen bases located predominately on the Arabian peninsula. Two of these bases—actually large civilian airports—accommodated over one-third of all U.S. tankers.

[2]This figure includes all tankers situated in theater, including those at Diego Garcia; tankers at Incirlik, Turkey, supporting air strikes against northern Iraq; and tankers supporting B-52 attacks from European bases.

Coalition combat aircraft were almost equally divided in terms of the equipment they required to accomplish in-flight refueling. All Air Force fixed-wing aircraft are standardized on the boom/receptacle system[3] and were refueled by Air Force tankers during Desert Storm. Boom-equipped tankers can only refuel one aircraft at a time. On the other hand, the Navy, Marine Corps, and most allied fighters use a probe/drogue system.[4] A boom drogue adapter kit permitted Air Force tankers to refuel naval or allied aircraft, although attaching the kit limited those tankers to probe-equipped aircraft.[5] Air Force support of Navy aircraft was supplemented by British and Navy tankers. Marine Corps fighters were refueled primarily by their own KC-130 tankers. The aircraft of coalition allies generally refueled from their own tankers, but U.S. Air Force tankers supported a few allies. Marine Corps, British, Saudi Arabian, and Canadian tankers have twin, wing-mounted drogues and can refuel two aircraft simultaneously, a capability known as multipoint.

Planning for a significant level of theater air refueling support—an average of about 240 Air Force tanker missions involving the refueling of more than 1,000 aircraft each day—was a complex task carried out under severe time constraints. It was the last step in the development of a daily strike plan, a task that could not begin until daily priorities had been established and targets selected. Generally, combat aircraft were refueled before and sometimes after striking Iraqi targets. In addition, more predictable, periodic refueling was required by support aircraft such as airborne warning and control systems (AWACS) and reconnaissance platforms that operated around the clock. Refueling was provided either by tankers flying along a lengthy track starting south of and headed towards Iraq or by tankers orbiting at a designated location. The limited airspace was congested with up to 45 such designated refueling areas and with tankers typically stacked vertically at various altitudes as well. With the declaration of coalition air superiority in late January, tankers routinely refueled aircraft from orbits located inside Iraq.

[3]The boom is a telescoping tube mounted near the tail of a tanker. During refueling, the boom operator aboard the tanker maneuvers the tip of this tube into a receptacle aboard the receiver aircraft.

[4]In the probe/drogue system, a hose and reel mechanism attached to a tanker aircraft releases a funnel-shaped basket connected to a flexible hose. To refuel, the pilot of the receiver aircraft inserts a pipe, called a probe, into the basket.

[5]Only the KC-10 with both a boom and a fuselage-mounted drogue can refuel Air Force and naval aircraft on the same mission.

Tankers Met Needs, but Inefficiently

The Central Air Forces (CENTAF) commander characterized tanker support for the opening salvo of the air war as an almost perfect implementation of an extraordinarily complex air refueling plan. After the war, the Air Force Chief of Staff noted that "the tanker contribution to Desert Storm is what made it [the air war] work." Without the significant level of air refueling support provided during Desert Storm, the tempo and intensity of the air campaign would have been substantially diminished. According to the Air Force, KC-135 and KC-10 tankers flew almost 14,000 combat sorties while transferring about 725 million pounds of fuel to roughly 50,000 receiver aircraft.

Despite the lack of emphasis prior to 1990 on air refueling under stressful, conventional-type scenarios, the particular circumstances of Desert Storm helped to mitigate the ensuing challenges. The 5-1/2-month period between the August 1990 Iraqi invasion of Kuwait and the coalition response allowed much needed time to identify planning, equipment, and training shortcomings and to work around problems. In addition, coalition partners provided ample bases and fuel for a large number of combat and support aircraft—including the largest tanker force ever assembled.

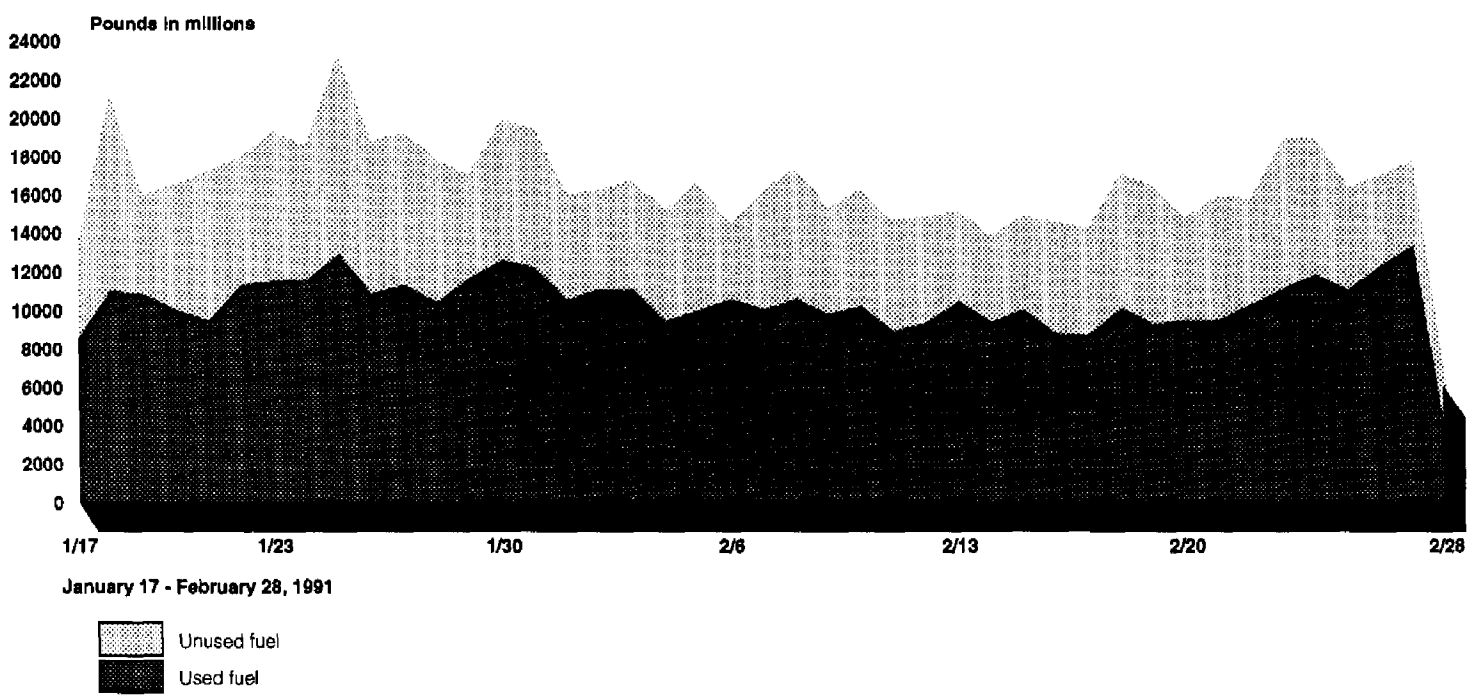
CENTAF after-action reports not only stressed that tankers were an indispensable asset but also asserted they were "the limiting factor" in generating additional combat missions. While available combat aircraft could have conducted more strikes, the number of tankers could not be increased because both bases and air space were saturated with aircraft. As a result, the CENTAF Deputy Chief of Staff for Operations was forced to cancel some strike packages and decrease the size of others to reduce the tanker requirement. This situation made it critical for CENTAF tanker planners to scrutinize the schedule and make more efficient use of the refueling assets on hand. DOD officials challenged the characterization of tankers as the limiting factor in increasing the number of combat missions, citing other considerations such as weather or fighter turnaround times. In the judgment of CENTAF officials, however, tankers were the most critical limitation.

Paradoxically, tankers often returned to base with a large amount of unused fuel,[6] some of which had to be dumped in order for the tanker to

[6]Early in the war, the CENTAF commander suggested that tankers stay on station longer if they still had a considerable amount of fuel available. This option was vigorously opposed by tanker planners since it challenged the system already established for managing tanker assets. For example, if a tanker's return to base was delayed, it might be unavailable for its next scheduled mission. The snowball effect from numerous such changes was deemed unmanageable.

land.[7] Thus, the limiting factor proved to be the efficiency of tanker operations rather than the actual number of tankers available. Since the Air Force was unable to provide data on unused fuel, we developed our own statistics using tanker unit situation reports. (See Scope and Methodology section for further details.) Our analysis showed that, on average, 40 percent of the fuel tankers carried on missions went unused. (See fig. 1.)

Figure 1: Comparison of Used/Unused Fuel at Three Tanker Bases



Note: These three bases represented two-thirds of the Air Force tankers scheduled by CENTAF planners. Data was unavailable for all tankers.

Contrary to the concern of CENTAF officials, little unused fuel was actually dumped. CENTAF Supply Support Activity data for all reporting in-theater tanker units suggests that about 17 million pounds of fuel were

[7]A tanker cannot land with as much fuel as it can carry aloft and must dump fuel if an insufficient quantity is not used or off-loaded.

jettisoned—over one-half during the first 2 weeks of the war.[8] This jettisoned amount represents a small fraction—less than 3 percent—of the total fuel transferred during combat missions.

Generally, the percentage of unused fuel for the three tanker units we analyzed declined as the war progressed, suggesting that there was an improvement in the efficiency of air refueling assets during the war. During the first week of the war, 41.5 percent of the fuel carried aloft by these three units was unused during transfer to 5,077 receivers. By the final week of the war, unused fuel dropped to 35 percent, while the number of receivers jumped to about 6,100.

A coalition ally analyzed the performance of its tankers during Desert Storm and also noted that they either dumped fuel or returned with large unused amounts. Dumped fuel totaled about 12 percent of what was actually transferred to receivers, and 85 percent of the tanker sorties transferred less than 50 percent of their available fuel.

A key lesson learned during Desert Storm is that the ability of air refueling operations to support combat missions is limited not only by the number of tankers but also by the efficiency of fuel transfer. The serious airspace constraints experienced during Desert Storm suggest that circumstances may not always permit an increase in the number of tankers to support more fighter sorties. On the other hand, had refueling been more efficient, fewer tankers could have sustained the same Desert Storm operational tempo with less congestion and greater safety.

Post-Desert Storm Air Force tanker requirements studies have not addressed operational efficiency during conventional combat. For example, a 1991 assessment "adopted" the number of tankers committed to Desert Storm as "the worst case contingency requirement" for its study. A 1993 study also relied on the Desert Storm tanker commitment as a baseline for future needs but increased the overall requirement to permit the more intensive use of tankers—a lesson it attributed to Desert Storm. Neither study acknowledged tanker efficiency as a variable that could be managed to lower the overall tanker requirement. DOD officials pointed out that two post-Desert Storm studies used to justify the KC-10 multipoint program cited increased operational and scheduling efficiency. However,

[8]Although the KC-135R model tanker only represented about 28 percent of the tankers that reported dumping fuel, it accounted for about 60 percent of the fuel jettisoned. The KC-135R, the most modern KC-135-type tanker, can take off with the most fuel. The extent to which it jettisoned fuel suggests that under these operational conditions, its larger fuel capacity was wasted.

these studies were limited to the impact on naval air operations, and their results were not applied to large-scale operations involving the Air Force.

Factors That Contributed to Air Refueling Inefficiencies

According to CENTAF tanker experts, inefficiency is inherent in any endeavor as unpredictable as warfare and the availability of excess fuel provided a margin of safety that at times proved to be invaluable. Nonetheless, some of the inefficiency was avoidable. For example, our analysis shows that KC-10s were the most efficient Air Force tankers during Desert Storm, dumping almost no fuel and returning to base with the least amount of unused fuel—about 29 percent compared to almost 42 percent for the KC-135R. Areas that contributed to inefficiencies in air refueling operations included receiver requirements, tanker planning, refueling equipment, communication, and aerial refueling doctrine. An additional factor, training, is addressed in a subsequent section.

Receiver Fuel Requirements

Throughout the war, more fuel was requested than was actually required as evidenced by the large number of aircraft that (1) failed to show up for their post-strike refueling or (2) needed much less fuel exiting Iraq than had been estimated. For example, at 2 of 9 in-theater bases, no receiver aircraft showed up for 111 tanker missions.

Fuel estimates were the responsibility of operational planners in the fighter and bomber units. According to CENTAF tanker experts, however, it quickly became obvious that some planners were stating their fuel requirements in terms of a worst case scenario—factoring in low-altitude operations, battle-damaged fuel tanks, threat evasion, and extra time over the target. For example, F-111s continued to base their requests on fuel-intensive, low-altitude operations long after the air war had transitioned to higher altitudes and a lower threat environment. After the war, one tanker unit noted that it almost never gave F-117s even close to their full post-strike off-load request. One official told us that, as with tanker planners, operators lacked the time and automated tools to more precisely calculate post-strike fuel requirements. Thus, he noted that fuel requirements for fighter missions were often calculated by doubling the amount of fuel required to get the aircraft to its target. A coalition ally's analysis of its own tanker operations similarly found receiver fuel requirements to be overstated. The report concluded that building extra fuel into the requirements was understandable, but that experience over the weeks of the war should have allowed a closer estimate of the actual fuel transfer required.

We asked if some mechanism or procedure was needed to ensure that fuel requests were reasonable. A CENTAF tanker expert pointed out that, during pre-hostilities planning, a senior officer had been involved in making F-15 fuel requests more realistic—an essential step, because the requests would have seriously limited the fuel available to other users. However, another official noted that excessive fuel requests were hard to identify during the war because of poor feedback from tanker units as to the identity of "no-shows." Thus, overstated F-111 fuel requirements were only discovered accidently when a pilot alerted his assigned tanker that they were no longer flying low-altitude missions and did not need to schedule post-strike fuel. In addition, tanker planners aboard the AWACS had also noted and raised questions about the need for F-111 post-strike refuelings. F-111 fuel requests were subsequently lowered.

Planning Tools

Either automation or sufficient planning time is required to optimize the use of tanker assets. CENTAF tanker planners lacked both. A computer program that had long been used to develop nuclear strike plans proved unsuitable for conventional planning. The program was too slow, was intended for much smaller groups of receivers, and was not designed for a large tanker force that flies constantly. While 5-1/2 months were available to meticulously plan refueling support for the first day of the war, planning time was significantly compressed once the war began. Lacking automation and the time required for meticulous calculations, CENTAF planners found themselves unable to efficiently assign tankers within the allotted 6 to 9 hours. Some of the procedures developed to meet planning deadlines introduced inefficiencies. For example, tanker capacity and receiver fuel needs were roughly matched using planning matrices. CENTAF tanker experts noted that more efficient pairings could have been developed with automated tools.

After Desert Storm, the Air Combat Command[9] incorporated a tanker planning module into the development of a new Air Force integrated combat planning system. Fielding of this software was underway in mid-1993. Tanker personnel with Desert Storm experience noted that the planning module has major room for improvement. It does not automatically assign and efficiently use the available tankers. The Command recognizes that the module is not a mature system and that greater automation is required. A CENTAF official told us that the goal is to acquire the type of automation already found in an existing Air Mobility

[9]Under a June 1992 Air Force reorganization, the former Tactical Air Command was renamed the Air Combat Command.

Command system. Unfortunately, the Air Mobility Command's automation, which is generally acknowledged to be superior, was developed by a different contractor and is not being substituted for the Air Combat Command module.

Tanker-Receiver Ratios

CENTAF operational planners limited the number of Air Force receivers assigned to refuel from a tanker. According to CENTAF tanker experts, the tanker-receiver ratio was especially inefficient with respect to F-16s, which totaled about one-third of Air Force combat aircraft in theater. For example, a late February 1991 strike plan scheduled a KC-135R model tanker to off-load 60,000 pounds of fuel to a cell of six F-16s. Assuming a typical 4-hour mission—flying to the rendezvous point, refueling the fighters, and returning to base—the tanker would only be using about one-half of its off-load potential. The ratio for nighttime F-16 missions was initially set at one tanker for every four fighters. Although both the day and nighttime limits were eventually raised, we were told that they never went above eight F-16s per tanker.

A tanker planner said the limit resulted from safety concerns under combat conditions, especially inadequate pilot experience in nighttime refueling. This planner noted that there is no standard prescribed by regulation as to the maximum number of F-16s that can be assigned to a tanker. Air Combat Command officials said that four fighters is a standard operating cell and that there is a concern about larger cells, especially in poor weather. They agreed, however, that cell size need not be increased in scheduling more such fighter groups to refuel from a particular tanker. Limiting the tanker-receiver ratio was not an alternative open to the Navy, given the small percentage of Air Force tankers available to them. A CENTAF tanker planner told us that, compared to Air Force fighters, about 1.5 as many naval fighters refueled from each tanker.

Refueling Equipment

As discussed in our earlier report, Air Force reliance on single-point tankers sometimes required more tankers than was dictated by fuel requirements alone. Thus, extra single-point tanker missions were generated during time-constrained operations because refueling time—not quantity—was the limiting factor.[10] Conventional air war tactics stress the need to overwhelm enemy defenses with a large group of fighters over a brief period of time. Since multipoint tankers have two off-load points, in

[10]In addition to using extra tankers, planners promulgated an expedited refueling procedure to move fighters on and off the boom more quickly.

these circumstances they would have been able to meet the tighter time constraints dictated by conventional operations with fewer tankers. Similarly, additional tankers had to be used to support missions containing both probe- and receptacle-equipped fighters to refuel both types of aircraft in the time allowed. Finally, the lack of standardization in refueling equipment required the Air Force to dedicate a portion of the tanker fleet to support probe-equipped naval aircraft.

As we reported in July 1993, adding probes and multipoint to Air Force aircraft would reduce scheduling and coordination problems and increase the overall efficiency of tanker operations. Although a probe and multipoint initiative was proposed by the Secretary of the Air Force, inaccurate Air Force analyses resulted in a decision not to equip fighters with probes. Subsequent to the issuance of our report, Lockheed successfully flight-tested a probe-equipped F-16, casting further doubt on the objectivity of Air Force analysis that had seriously questioned the operational feasibility of this modification. At that time, DOD officials concurred with our recommendation that an objective reevaluation of the initiative from a cross-service perspective was warranted. In response to this report, DOD took a definitive position that probes were not a cost-effective modification to Air Force fighters. This position was taken without the objective reevaluation DOD agreed was needed. We continue to believe that an objective reassessment of the initiative should be conducted by the Secretary of Defense's Office of Program Analysis and Evaluation.

Air-refuelable tankers could also boost the efficiency of refueling operations. Currently, only 59 KC-10s and 8 KC-135 tankers can be refueled during a mission. CENTAF tanker experts explained that extra fuel from KC-135s was often transferred to airborne KC-10s, preventing even more fuel from being dumped or returned to base unused. Our analysis shows that KC-10s were frequently refueled during Desert Storm, contributing to both longer missions and more receivers per tanker sortie.

Communication

Poor air-to-ground and ground-to-air communication impeded effective battle management and also contributed to unused fuel. One official described some of the communication equipment used during the war as outmoded, resulting in a system that was slow, inefficient, and unreliable. The lack of a more responsive communication network was particularly frustrating because numerous mission changes occurred during the execution of the daily strike plan. The changes often resulted from poor

weather in the target area, lack of bomb damage assessments for high priority targets that were then scheduled to be restruck, or new target priorities. According to CENTAF tanker planners, although they flew aboard AWACS to coordinate air refueling changes, their inability to cancel scheduled tankers because of communication problems with ground stations resulted in unused fuel. Conversely, messages intended for the AWACS air refueling coordinator were often bottlenecked at the AWACS communication desk of the CENTAF battle operations center. One official told us that handwritten messages were put in a box, broadcast by a radio operator to an AWACS operating overhead, written down again, retransmitted to the air refueling coordinator aboard a different AWACS, and then finally communicated to the appropriate tanker. This communication system resulted in fighter mission aborts because the tanker had not received the critical mission changes. It also made it difficult to match excess fuel from tankers that took off before their receivers' mission was canceled with receiver missions added to the daily strike plan at the last minute.

Doctrine

Desert Storm was the first large-scale conventional employment of tankers since Vietnam. As a result, personnel with experience in developing methods to support air refueling operations on the scale of Desert Storm were nonexistent. Both during and after the war, CENTAF personnel suggested numerous ways to improve tanker employment and efficiency in the conventional arena, including (1) increasing the reliance on orbits to provide air refueling, a system used extensively during Vietnam;[11] (2) using the KC-10 as a fuel depository, fed and augmented by KC-135s, thereby allowing it to stay on station for longer periods of time; (3) increasing the ratio of receivers to tankers; and (4) utilizing different tanker models in the same group of tankers to more closely approximate receiver off-load requirements.

[11]Although a shift to an orbit structure was considered during the first week of the war, the track structure was kept largely intact due to concern over congestion near the Saudi-Iraq border and the F-16s' need for fuel soon after takeoff (the F-16 was trading weapons for fuel). Some officials argued that greater reliance on orbits would have reduced the serious airspace congestion, made it easier to respond to the fluid battlefield environment, and probably have allowed requirements to be met with fewer tankers.

Peacetime Air Refueling Training Underemphasized Conventional Operations

According to Air Force after-action reports, the tanker and fighter force was less than optimally prepared for the most time-compressed and intensive air refueling operation in history. Thus, the CENTAF director of tanker operations noted that it would have been impossible to provide support on the scale required during Desert Storm on short notice without the luxury of 5-1/2 months to begin addressing long-standing peacetime training deficiencies. These deficiencies fell into three overlapping areas—conventional preparedness, planning skills, and training realism.

The emphasis of pre-Desert Storm training was not on conventional operations. Thus, tanker crews proved to be unfamiliar with the role and capabilities of AWACS aircraft or with tactical fighter terminology and the required responses. One official explained that his unit was essentially tied to refueling strategic bombers during peacetime, but during Desert Storm the unit supported C-130s, A-10s, and F-15s, as well as other types of fighters. Additionally, in the fall of 1990, tanker planners found it necessary to write and distribute a "much needed supplement" to the aircrew tactics manual focusing on operations under hostile fire. An after-action report noted that the definition of tactics needed to be expanded to include a thorough knowledge of the threat and ways to avoid and diminish its effect.

A second problem area—one directly related to the lack of emphasis on conventional operations—was an underestimation of the planning complexities involved in such a massive and time-compressed air refueling operation. According to the CENTAF director of tanker operations, inadequate peacetime integration of tankers into tactical air operations was nearly a "showstopper" during Desert Storm. Tanker and tactical fighter planners were not used to working together and did not clearly understand each others' needs. For example, he noted that fuel is always available to meet receiver requests during exercises. However, during pre-hostilities planning, fighter planners were surprised when their fuel requirements for the first day of the war had to be adjusted downward to match the availability of tanker assets. Similarly, during the war, the number of receiver sorties was reduced to a level that could be supported on a constant basis for an extended period of time. This official strongly believed that tanker and receiver planners needed to be collocated during exercises and that limits should be placed on the number of tankers available in exercises to make the receiver community think about economizing.

Third, some aspects of peacetime air refueling training lacked realism. Peacetime training focused on developing individual crew qualification skills rather than on acquiring the skills necessary to operate safely and successfully in a wartime, composite force environment. For example, refuelings involving large groups of tankers and large packages of fighters in crowded airspace, frequently at night, were a common occurrence throughout Desert Storm. A post-war report noted that nighttime refueling training by large groups of tankers was inadequate and that unit commanders needed to be directed to put more emphasis on such events. A logical corollary to this problem—safety restrictions due to the inexperience of large fighter groups with nighttime refueling under combat conditions from a single tanker—was discussed earlier.

Although tankers had long supported peacetime tactical fighter exercises known as Red Flag, tanker personnel commented that the exercises were not realistic: tankers were not integrated but rather sat on the sidelines and occasionally provided fuel. For example, tanker personnel noted that they were not involved in pre- and post-mission exercise debriefs, the opportunity to plan was limited, and only a few units actually had the opportunity to participate.

Finally, joint force training—that is, training with the aircraft of sister services—was insufficient.[12] Consequently, in the fall of 1990, an intensive training program was established for naval aviators to familiarize them with the difficult-to-use boom drogue adapter kits—equipment with which they had very little peacetime experience. CENTAF officials also indicated that Air Force tanker personnel were exposed to Navy rendezvous and refueling procedures, which differed significantly from those of the Air Force and from those published in then-current manuals. One CENTAF official noted the early difficulties in working with tactical aircraft. He acknowledged that the learning curve on working with naval aircraft was particularly steep, in part, because previous war plans had not anticipated naval fighter support on such a scale and little training or planning had been done to facilitate it. Another official noted that there had been few joint exercises.

Some steps have been taken to address training problems that surfaced during Desert Storm. For example, the Air Force has developed a tactics course that includes familiarization with the role of AWACS for tanker crew members. The Air Force has also started a course for tanker planners who

[12]For a detailed assessment of the complications introduced by the joint service operating environment and the impact on naval air operations, see Naval Air Operations: Interservice Cooperation Needs Direction From Top (GAO/NSIAD-93-141, May 19, 1993).

will serve aboard AWACS to help coordinate the execution of air refueling operations in future contingencies. Tanker planners are currently being used on AWACS during joint exercises that have a high degree of tanker participation. Finally, officials at the Air Combat Command told us that tanker involvement in Red Flag exercises has improved since Desert Storm. Tanker personnel are now situated at the same location and participate in the briefings. In addition, consideration is being given to utilizing scenarios that would involve more active tanker planning and support.

Despite these improvements, progress has been slow in at least three areas. First, we were told that a training master plan was still being developed that would address programs to qualify staff tanker planners, such as those that supported CENTAF during Desert Storm. Second, officials at the Air Mobility Command noted that in order for the tactical aircraft community to have more training in the nighttime refueling of large groups of fighters, it would have to seek out the training, but to date there had been no such increase in requests. Finally, peacetime air refueling training hours still appear to be distributed inequitably within strategic and conventional mission areas. Prior to Desert Storm, about 250 strategic bombers consumed approximately the same number of refueling training hours as 3,000 Air Force tactical fighters; training hours for about 1,700 naval tactical assets were only 10 percent of the hours allocated to Air Force fighters. Current and future allocations reflect a decreased but still disproportionate share of training hours being used by a shrinking bomber force. Thus, an approximately 30-percent scheduled cut in the size of the bomber force only yielded a 20-percent decrease in bomber refueling training hours. Furthermore, naval training hours remain at the same low level that existed prior to Desert Storm—about 10 of the hours allocated to Air Force fighters. To increase naval proficiency, overall training hours would have to be increased or some other users' hours would have to be decreased.

Recommendations

To improve the efficiency of air refueling operations in future contingencies, we recommend that the Secretary of Defense direct the Secretary of the Air Force to ensure

- the collection and analysis of detailed data on tanker efficiency—used, unused, and jettisoned fuel—during exercises as well as future conflicts;

- explicit examination in future DOD tanker requirements studies of the implications of increased efficiency due to improvements in equipment, communication, doctrine, and training;
- development of needed improvements to the automated tanker planning module currently being fielded, including examination of the feasibility of substituting the existing Air Mobility Command system for the one under development by the Air Combat Command;
- assignment of a high priority to studies, research, and exercises intended to develop effective methods for tankers to support future combat operations; such efforts should actively involve the tactical community;
- implementation of an improved and more realistic simulation of expected wartime conditions in peacetime air refueling training and exercises as well as increased emphasis on preparing for refueling operations in conventional as opposed to nuclear scenarios; and
- a more equitable sharing of peacetime air refueling training hours both among the services and between strategic and tactical assets.

We also recommend that the Secretary of Defense direct the Chairman of the Joint Chiefs of Staff to issue guidance requiring the establishment of a mechanism within future joint component air commands to ensure the validity of fuel requirements.

Agency Comments and Our Evaluation

In commenting on a draft of this report, DOD officials said that most of our recommendations are being or will be implemented through existing mechanisms such as training exercises. In addition, they characterized many of the recommendations as being of a sufficiently narrow scope that they did not warrant specific high-level direction from the Secretary of Defense. Consequently, DOD only "partially concurred" with our seven recommendations.

We are skeptical that the actions required to ensure more efficient air refueling operations in future contingencies will occur without active oversight and direction from the Secretary of Defense. As noted in our July 1993 report, Air Force studies on the aerial refueling initiative were inaccurate and relied on unrealistic assumptions. We believe that the multiservice and multinational repercussions of tanker operations warrant the broader perspective of the Secretary of Defense.

DOD officials suggested that it was unnecessary for the Secretary of Defense to specify consideration of the implications of increased efficiency in future studies because such factors are elementary and are

being "continually evaluated." We found that a number of tanker requirements studies conducted since Desert Storm assumed that the conflict provides a requirements benchmark and a model for future tanker operations. Despite significant testimonial evidence about the inefficiency of air refueling operations, the Air Force never systematically measured the level of unused and jettisoned fuel, identified the causes, or initiated corrective measures. To date, these factors have been overlooked by Air Force research and analyses.

Similarly, DOD told us that there is an established process for allocating aircraft flying hours and that high-level direction from the Secretary of Defense to single out tanker flying hour allocations would be inappropriate and unnecessary. However, we found that the allocation of refueling hours between strategic and conventional operations had not changed markedly. For example, 2 years after Desert Storm, peacetime refueling training by naval aircraft remains at the same low pre-Desert Storm level. We believe that intervention from the Secretary of Defense may be required to ensure that naval aviators are better prepared to refuel from Air Force tankers than they were during Desert Storm—a conflict fortuitously preceded by a 5-1/2-month warning period that allowed the Navy to achieve the required level of proficiency.

Finally, DOD stated that (1) an effective process already exists to identify and communicate valid receiver fuel requests and (2) it was appropriate to base fuel requests on worst-case scenarios. DOD, however, did not identify that process or explain fuel validation procedures. We believe that Desert Storm experience contradicts the existence of an effective system. Both before and during Desert Storm, commanders challenged the fuel estimates developed by operational planners at specific fighter units. Thus although F-15 and F-111 fuel estimates were based on demanding, worst-case scenarios, these units were directed to lower their requests. Our finding that an average of 40 percent of the fuel carried aloft by tankers went unused suggests that a more systematic approach is required. Such a mechanism is clearly in the interests of the joint component air commander since unnecessary fuel requested by one user unreasonably limits the fuel available to other aircraft or increases the overall number of tankers required to support operations.

Scope and Methodology

We assessed the efficiency and effectiveness of Desert Storm air refueling operations by (1) extensively interviewing CENTAF officials involved in planning and directing tanker operations during the war as well as

commanders and crew members at several tanker operating locations, (2) discussing training requirements for both tanker and combat aircraft crews at the Air Mobility and Air Combat Commands, (3) reviewing numerous after-action reports and official histories, and (4) developing a database on consumed versus available fuel using daily situation reports from three tanker units accounting for about two-thirds of Air Force assets in theater.

Because of the emphasis on efficiently using the available tanker assets, we asked the Air Force to provide daily statistics on the amount of fuel that was available to receivers, the amount actually transferred, and the amount unused—that is, not transferred and either dumped or returned to base by tankers. Officials at the command responsible for managing tankers[13] told us that no daily statistics had been kept on available/used/unused fuel. Although the CENTAF Supply Support Activity collected daily fuel usage data, units outside the theater were excluded, some in theater units did not report, and CENTAF tanker planners questioned the accuracy of some of the data. The Support Activity, however, was able to provide partial information on dumped fuel. In order to gain additional insights on air refueling efficiency, we collected and aggregated information contained in daily tanker unit situation reports for three bases representing about two-thirds of the tankers situated in theater. We believe that the results of our analysis are representative of the overall level of efficiency in air refueling operations because (1) the three tanker units were in different geographic areas on the Arabian peninsula, (2) most tanker models were represented at two different bases, and (3) the amount of unused fuel was generally consistent for the same model at different bases.

We obtained and analyzed data contained in daily situation reports for three Desert Storm tanker units. Generally, situation reports contained detailed information by tanker model on each day's flying activities, including the number of sorties and hours flown, amount of fuel transferred, and number and type of receivers refueled. Since the situation reports for one unit did not contain off-load data for KC-135R tankers supporting F-117s, those missions were excluded from our analysis.

The amount of fuel available on tanker missions was estimated from the "Contingency Tanker Off-load Chart" used by tanker planners during the war. For each location, by tanker model, it provides the standard fuel load

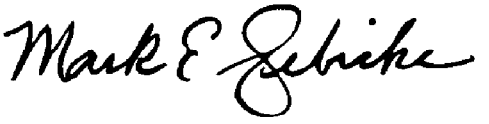
[13]In June 1992, management of the majority of Air Force tanker assets was transferred from the Strategic Air Command to the Air Mobility Command.

and the amount of fuel available for transfer to receivers based on the duration of the mission. Planners indicated that standard fuel loads were used because it was simpler and prevented mistakes such as mixing up the fuel load of one mission with that for another. This "available for transfer" excludes the fuel consumed by the tanker during its mission and a 20,000-pound fuel reserve. After calculating the average sortie duration for each model tanker, we multiplied the number of sorties flown by the appropriate amount of fuel available for transfer. For example, a KC-135E tanker operating on a 4-hour mission had 95,000 pounds of fuel available for transfer. Thus, the 31 sorties flown on the first day of the war could have transferred about 3 million pounds of fuel. Unused fuel is the difference between fuel available and fuel actually transferred.

Our review was conducted between January 1992 and February 1993 in accordance with generally accepted government auditing standards.

We are sending copies of this report to other interested committees and Members of Congress; the Secretaries of Defense, the Air Force, and the Navy; and the Director of the Office of Management and Budget. We will also make copies available to other parties upon request.

Please contact me at (202) 512-5140 if you or your staff have any questions concerning this report. The major contributors were Julia Denman, Assistant Director; Walter Ochinko, Evaluator-in-Charge; Trisha Kurtz, Evaluator; Joy Labez, Evaluator; and Howard E. Kapp, Evaluator.



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