Energy and Reason: Securing and Sustaining Global Reach for the US Air Force

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1. Introduction

The Air Mobility Command (AMC) is one of the U.S. Air Force's major operational commands. The command's role is Global Reach—using aircraft to deploy America's armed forces anywhere in the world and to sustain them with a ready stream of supplies and equipment. The very first major airlift operation, conducted when the Air Force was only a few months old, was the Berlin Airlift. During this humanitarian effort, over 2.4 million tons of food, coal, fuel and other vital supplies were delivered to Berlin's 2.2 million inhabitants. Air refueling aircraft, called "tankers" are force multipliers—extending the range, payload and mission versatility of other Air Force platforms. Any AMC aircraft can perform the critical role of aeromedical evacuation—moving patients out of harm's way, be it in the Global War on Terrorism or in response to natural disasters such as the tsunami in Asia or the recent hurricanes, Gustav and Ike in the United States.

The command has over 140,000 military and civilian personnel, who operate, maintain, and support a Mobility Air Force's fleet of nearly 1,500 aircraft which fly airlift, aerial refueling, and aeromedical evacuations across the globe. On a typical day, U.S. air mobility forces fly about 900 sorties and move nearly 2,000 tons of cargo and more than 6,000 passengers. This incessant tempo equates to a mobility aircraft departure, somewhere in the world, every 2 minutes.

The capability to deliver "anything, anywhere, at any time" exacts an enormous fuel and energy price. Within the U.S. government, the Department of Defense is the largest consumer of petroleum-derived fuels. As illustrated in Figure 1, within the Defense Department, the Air Force leads the other services in its use of fuels. And within the Air Force, the mobility mission accounts for the largest share.

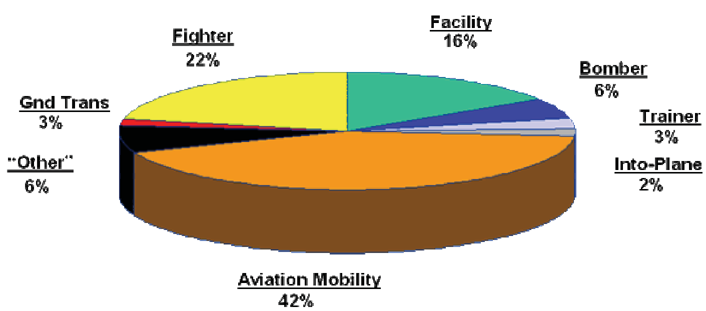

Figure 1. Distribution of the consumption of petroleum-derived fuels within the U.S. government Department of Defense [1].

2. Key Features

The United States and the world depend on uninterrupted air mobility operations. To that end, our command is engaged in a broad spectrum of energy initiatives and programs.

For operational flight, the Bruget range equation provides a simple formula for the distance flown for a given amount of fuel:

$$Aircraft\ Range = \frac{Velocity}{TSFC}\frac{lift}{Drag} ln\left(1 + \frac{W_{fuel}}{W_{PL} + W_o}\right) \quad (1)$$

where Velocity represents the aircraft velocity, TSFC is the engine fuel consumption, Lift and Drag are the lift and drag aerodynamic forces acting on the aircraft, respectively, and W_{fuel} and W_0 represent the weights of fuel and aircraft structure, respectively. Our command is exploring advances in better fuel consumption, more streamlined aerodynamics, and reduction in weight as methods to improve our fuel efficiency. Some advances being considered include winglets and even formation flying. Figure 2 depicts the evolution of petroleum-derived fuel consumption by AMC.

A major effort has been the certification of the C-17 cargo airlifter to use coal-derived Fischer-Tropsch fuel blends (Figure 3). The approach was risk-based and started with the determination of the characteristics and properties of the Fischer-Tropsch fuel. Next, the fuel was tested in a small, helicopter engine in the laboratory. The tests graduated to off-aircraft ground tests on the Pratt & Whitney F117 engine in a hard stand, then on the aircraft on the ground. Flight tests progressed from single engine operations to use on all four engines. The tests included airstarts, transients and performance across the flight envelope. The process employed has been captured in an Air Force-wide certification handbook and is being applied to other U.S. Air Force aircrafts, with the goal of certifying the entire fleet by 2011. A recent milestone was the first successful aerial refueling using the Fischer-Tropsch fuel blend.

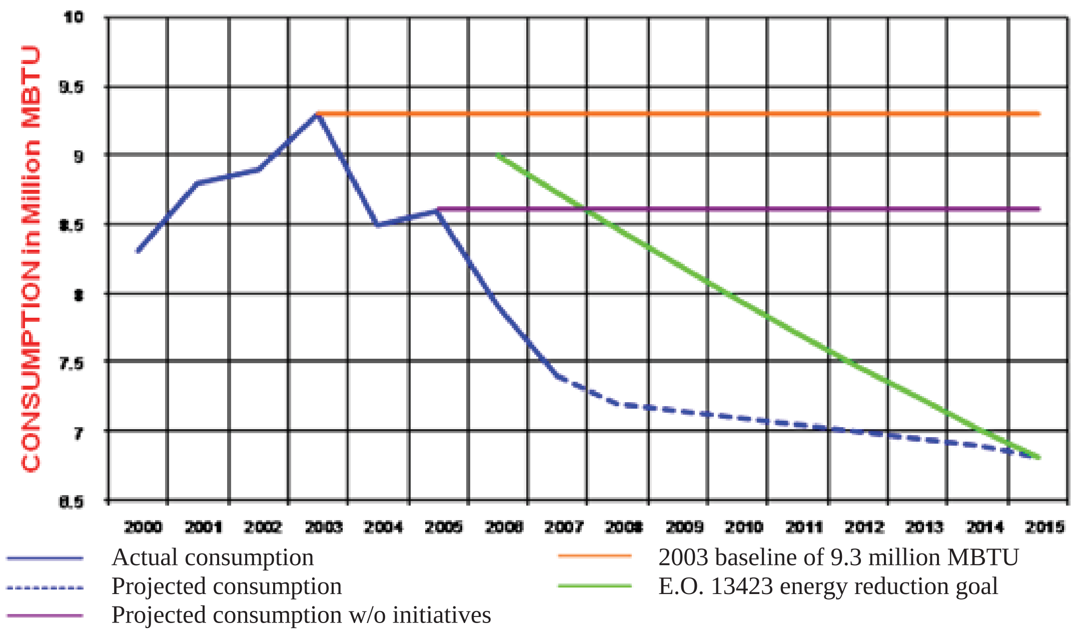

Figure 2. Evolution of petroleum-derived fuel consumption by AMC.

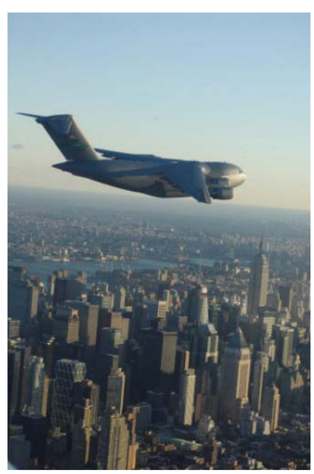

Figure 3. First transcontinental flight of a C-17 on synthetic blend fuel.

As with many industries and enterprises looking to improve performance, one of AMC's greatest challenges is a culture accustomed to plentiful energy. Education, training, and collection of relevant metrics are helping us turn the tide towards reduced consumption. Aircraft simulators help reinforce good aircrew behavior. High fidelity simulators can even qualify and substitute for required in-flight training.

AMC maintains twelve air bases and numerous tenant operating sites worldwide. We have set some very aggressive goals for energy management, cost-savings, and environmental stewardship. Part of our efforts involves smart investing, elimination of inefficient infrastructure, and adoption of new, efficient technologies. Underlying all of this is a bedrock of improved measurements and monitoring of trends and milestones.

The Air Force has designated one of AMC's bases--McGuire Air Force Base in New Jersey--as a test-bed for new energy saving technologies. The base is reaching out to local experts and research centers such as Rutgers University. One of the base's "stretch goals" is to be energy neutral (all required energy generated on-site) by 2015. The lessons learned from McGuire are being migrated to other bases. Numerous sites and bases are investigating energy solutions in the form of low-velocity vehicles, wind turbines (Figure 4), bio-mass, "green" roofs, and solar cells. In general, a strategy which makes sense is to "think globally, but act locally"—taking advantage of the natural climate and resources at hand.

Figure 4. Wind turbines investigated at various AMC's sites and bases as an energy saving technology.

3. Conclusions

The AMC's approach to energy sustainment and security is very much a work-in-progress. As our enterprise strategy matures, increased emphasis is being placed on energy interfaces with other operational considerations such as resource management, environmental stewardship, training, and new energy sources.

4. References

1. DESC FY06 Cost Data, AFTOC, Fuels Enterprise System & Defense Utility Reporting System, and VEMSO fuel reporting system.

Speaker's Biography

Dr. Donald R. Erbschloe is the Chief Scientist of the Air Mobility Command (AMC), Scott Air Force Base, IL. The Chief Scientist the AMC Commander authoritative scientific counsel, technical advice and guidance. He also advises on the status of scientific and technical quality of AMC, AF and DoD programs and solutions to AMC mission area needs, engages subject area experts, and conducts efforts leading to technological enhancement of AMC capabilities.

Most recently, Dr. Erbschloe was the Acting Chief Operating Officer of the Department of Energy's Office of Science—a 1,000 person organization with an annual budget of $4.1B. The Office of Science manages 10 world-class laboratories and is the single largest supporter of basic research in the physical sciences in the United States.

Previously, Dr. Erbschloe had a 28 year military career in the US Air Force. His career was balanced among three primary thrusts; operations, academia, and scientific and technical management. He was a command pilot with 3,900 flying hours in the C-141, TG-7A (motorized glider), and UV-18. During his tour in the 86th Military Airlift Squadron at Travis Air Force Base, CA, he was the Chief of the Operations Center during Operation Just Cause and the Chief Pilot during Desert Shield/Desert Storm. He served three tours on the faculty at the Air Force Academy, as instructor through associate professor in the Department of Physics and as the Director of Faculty Research on the Dean of the Faculty staff. Following his first tour at the Academy he was sent to the University of Oxford for his doctorate. Following his second tour at the Academy he was selected as the Chief Scientist at the European Office of Aerospace Research and Development, a London-based detachment of the Air Force Office of Scientific Research (AFOSR). Following his third tour at the Academy, he was chosen as the Military Assistant to the Air Force Chief Scientist at the Pentagon. His final active duty assignment was as the Commander and Deputy Director of AFOSR in Arlington, Virginia.