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FUTURE WAR PAPER

$500 Crude Oil and Its Repressions on Marine Corps TACAIR
And the USMC - The Most Energy Dependent Service

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Executive Summary

Title: $500 Crude Oil and Its Repressions on Marine Corps TACAIR and the USMC - The Most Energy Dependent Service

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Thesis: The price of jet fuel has risen dramatically in the past few years as the cost of crude oil has hit over $100 per barrel. In the future there exists the potential for the cost of crude oil to increase even further, i.e. $500 per barrel. What are the second and third order effects of $8.00 per gallon jet fuel on Marine Corps tactical aviation?

Discussion: The original purpose of this paper was to explore the second and third order effects of this dramatic increase in the cost of jet fuel. However, as I began to study this issue I discovered that not enough scholarship has been done to examine just how closely jet fuel prices and the Marine Corps' TACAIR capability is linked. The Marine Corps has no appreciable way to minimize its reliance on jet fuel, and, in fact, is probably the most susceptible armed service to increased energy costs. The paper will determine that there is no appreciable way to improve the efficiency of tactical fighters and with a "zero sum" budget, any increase in the cost of jet fuel will result in fewer flight hours available. Since Marine Corps TACAIR is funded to just meet T – 2.0 requirements, any loss if flight hours will result in a loss of capability.

Recommendation: The Marine Corps' senior leaders must acknowledge that neither its current, nor future, TACAIR aircraft are suitable for future fuel efficiencies. The Marine Corps' striking power is directly tethered to jet fuel prices and only acknowledging this very point now will future steps be taken in our training and acquisition programs to minimize our dependence on jet fuel.

The strength of the Marine Corps lies in its ability to fight the Marine Expeditionary Force (MEF) single battle. The MEF single battle requires the Marine Air Ground Task Force (MAGTF) to operate with all three functional components; the ground component element (GCE), air combat element (ACE), and Marine logistics group (MLG), operating at their maximum potential. For the ACE to operate at its max potential it requires properly maintained aircraft flown by expertly trained pilots – and the jet fuel required to fly them. In just the past three years the price of jet fuel has increased from 87.1 nominal cents per gallon in 2003 to 196.4 nominal cents per gallon in 2006.[1] The Defense Energy Support Center (DESC), with the responsibility of supply

chain management for all Department of Defense (DoD) bulk petroleum purchases, reported an increase of 95% to $8.5 billion for all DoD jet fuel cost with only a 4% increase in jet fuel requirements between the years 2004 to 2006.[2] The reality is that energy requirements are going to be a significant factor in the Marine Corps budget is undeniable. The Marine Corps, through the Department of the Navy (DoN) and the DoD, has been able to weather this current dramatic increase in the cost of jet fuel through OIF/OEF "supplemental" spending bills. However, what about an even more dramatic increase, on the order of 500% occurring over an even shorter period of time (three months) and its effects on Marine Corps aviation and its ability to fight as a part of the MEF single battle?

The original purpose of this paper was to explore the first and second order effects on Marine Corps tactical aviation due to a very significant increase in the cost of jet fuel driven by a dramatic increase in the cost of crude oil, i.e. $500 per barrel. However, as research was conducted it became apparent that very little scholarship has been done to examine just how closely jet fuel prices and TACAIR capability is linked. The Marine Corps has no appreciable way to minimize its reliance on jet fuel, and, in fact, is probably the most susceptible armed service to increased energy costs. When these jet fuel prices rise in a "zero sum" budget there can only be one result, fewer flight hours, fewer expertly trained pilots, and therefore an ACE not able to perform at its maximum potential. The most important task now is for Marine Corps' senior leaders to acknowledge that neither its current, nor future, TACAIR aircraft are suitable for future fuel efficiencies. The Marine Corps' striking power is directly tethered to jet fuel prices

and only by acknowledging this very point now will future steps be taken in our training and acquisition programs to minimize our dependence on jet fuel.

While the current crude oil price is occurring during some global instability due to current operations in the war on terror and the weakened dollar, the Energy Information Administration (EIA) in its *Annual Energy Outlook 2007* report concluded that the reference price for crude oil would gradually decline to under $50 per barrel (2005 dollars) by 2014 and return to 2005 prices around 2030.[3] This may seem to be optimistic as crude oil prices approach $100 per barrel in December 2007, yet the EIA's best judgment is that OPEC producing countries will look to manage their production to keep crude oil at $50 to $60 (2005 dollars) per barrel to discourage more investment in non-OPEC countries conventional and unconventional supplies and to not discourage consumption of liquids worldwide. OPEC may desire to keep crude oil prices in the $50 to $60 per barrel range, but if the history of the past 35 years is any indication OPEC members themselves may be the primary cause of crude oil's next dramatic crisis.

OPEC was created in 1960 with the main goal of gaining greater control over the price of oil and coordinating the petroleum policies of its member nations.[4] OPEC was able to gain greater control, eventually, however, oil prices continued to gradually decline. Then in October, 1973, OAPEC (Organization of Arab Petroleum Exporting Countries) placed an embargo against the United States due to its support of Israel during the Yom Kippur War.[5] Due to this embargo, OPEC was able to raise the price of crude oil by 268% (200% of it in only two months) and this event would begin the relatively unstable period of crude oil prices, including three major price spikes, that exists up to today.[6] In 1979 the Iranian revolution would cause a 128% increase in crude oil prices

and the invasion of Kuwait by Iraq in 1990 would cause a 31% increase. Then an interesting development occurred in a country that isn't commonly known to be a member of OPEC.

Venezuela had until 2002 been a very stable oil supplier to the United States. Venezuela is a non-Arab country and had continued to provide oil to the United States even during the oil embargo in 1973.[7] In 1998, Hugo Rafael Chavez Frias, more commonly known as Hugo Chavez, became president of Venezuela and gradually expanded his control of the state oil company Petroleos de Venezuela, S.A. (PDVSA).[8] Then in 2002, these actions by Hugo Chavez led to two general strikes by oil workers who included not only the union labor, but the white-collars workers as well, which resulted in over 200 million barrels of crude oil being kept off the market.[9] Michelle Billig, writing in *Foreign Affairs*, makes a compelling argument that this crisis in Venezuela is the root cause of the dramatic increase in the cost of crude oil that the United States has felt over the past four years and that this crisis occurred during the preparations for the war in Iraq when U.S. focus was on a possible disruption in crude oil flow from the Middle East, not South America.[10]

This dramatic increase in the cost of crude oil would not occur according to the EIA in their *Annual Energy Outlook 2007* because as the price of oil increases over $50 to $60 per barrel it will make alternative energy sources economically viable. However, the current state of unrest in the Middle East due to the war on terror and the Israel/Palestinian conflict coupled with the United States' poor relationship with Iran and Venezuela, to include Hugo Chavez's flawed oil economic policies, make an alternative scenario possible.

The alternative scenario that would drive crude oil to $500 per barrel in today's dollars would begin with a secret agreement between just two OPEC countries. Iran's president, Mahmoud Ahmadinejad, and Venezuela's president, Hugo Chavez, for their own personal, yet mutually supporting reasons, decide that an oil crisis would be the solution to each of their countries internal economic affairs and their respective foreign policy situation with the United States. Ahmadinejad would be feeling very strong political pressure caused by the severe economic crisis that his country has endured due to sanctions placed on his county by the United Nations for its nuclear policies. Chavez would also be feeling political pressure due to his failing economy; however, Venezuela's failing economy would be the result of the socialist state that Chavez created when he nationalized Venezuela's oil producing, telecommunication and electrical companies in 2007. Both leaders' interest intersect when they believe a dramatic increase in the cost of crude oil would solve their economic situations and allow both of them to bolster their own popularity, albeit for different reasons. Therefore, Iran closes the Straits of Hormuz to all oil shipping except for tankers of OPEC nations or those escorted under the Iranian flag and Venezuela declares an oil embargo against the United States. These actions immediately send giant waves through the world oil market as the U.S. sees an immediate loss of 16.6% of its import capability and the world reacts to yet another energy crisis caused by members of OPEC.[11] With these actions Chavez and Ahmadinejad have caused the price of crude oil to jump in less than three months to $500 per barrel and instigated a world crisis. The increase in the price of crude oil and the world crisis are a cause of significant concern as the Marine Corps is forced to come to terms with a prolonged period of extremely high jet fuel prices and at the same time must

be prepared to execute kinetic options in response to this world crisis. These kinetic options will require expertly trained pilots and unmanned aerial system (UAS) operators.

This training requires flight operations and thus jet fuel, a great deal of jet fuel, and this fuel cost is a significant portion of the average cost per flight hour (CPFH). While "a great deal of jet fuel" is not a scientific term, the amount of energy the DoD consumes is staggering. In 2006, the DoD consumed 843.7 trillion BTU, over 79% of all energy consumed by the U.S. Government.[12] This energy cost the U.S. $12.8 billion dollars[13] and $8.5 billion[14] of this total cost was for jet fuel, with the U.S. Navy accounting for 30% of this $8.5 billion.[15] The figure for the U.S. Navy is important since all Marine Corps TACAIR aviation is funded from the Navy's Operation and Maintenance, Mission and Other Flight Operations (1A1A) budget line as part of overall DoD budget. In FY 2006 this single budget line had the highest overall cost of any of the Navy's budget lines, even exceeding Ship Depot Maintenance.[16] LtCol Kristine Blackwell found that "for every $10 increase in a barrel of oil, DoD's operating cost increase by $1.3 billion" and that this same $10 increase in a barrel of oil results in a $600 million dollar increase in the Air Force's annual fuel cost.[17] This same $10 per barrel would cost the Navy approximately an additional $345 million dollars per year in fuel cost.[18] If one is able to take a linear progression to crude oil costing $500 per barrel then jet fuel would cost the Navy approximately $16/gallon (eight fold increase) to purchase and would consume a fuel budget worth $23.7 billion dollars.

The ever increasing cost of jet fuel makes it necessary to examine how this cost is fed into the Navy's flight hour program (FHP) budgeting process. Projected fuel cost for a specific Type/Model/Series (T/M/S) is calculated by multiplying the T/M/S certified

fuel consumption data (most recent FY barrel per hour) X projected flight hours (which includes all training hours and MESH (mission essential support hours)) X OSD published barrel prices.[19] The DoD gets its published standard price for a barrel of fuel from the Office of Management and Budget (OMB). This fuel cost is then added to the maintenance cost (operational (Squadron), intermediate (MALS), and Depot) to get a total cost and then is broken down to "cost per flight hour (CPFH)." For the FY 2009 proposed DoD budget the Marine Corps TACAIR fuel cost per flight hour represent 26% of the total CPFH.[20] If fuel cost represents approximately 26% of total CPFH then an eight fold increase in the cost of jet fuel would approximately equal a 182% increase in the overall CPFH to operate Marine Corps tactical aircraft.

The DoD provides to the Uniformed Services a "price change memorandum" if the cost of fuel per barrel during the year of the budget execution increases. During the past four years these price changes have always been a price increase and with a balanced budget requirement the Navy has been fortunate to receive "supplemental" budget increases to cover this increase in fuel cost. These "supplemental" budget increases have allowed the Navy/Marine Corps TACAIR to continue to fly the flight hours programmed without having to make the tough decisions that would result from a very dramatic increase in the CPFH due to a global oil crisis as described earlier.

If all the crude oil imports were suddenly halted there would be no question regarding crude oil supplies for the DoD. While the DoD does consume 843.7 trillion BTU's of energy per year, the entire U.S. Government only consumes 1.9% of all crude oil consumed by the United States.[21] The DoD consumption in 2006 was 135.9Mbbl/year or .37Mbbl/day[22] and this crude oil requirement could be covered by

"the total annual production of two Gulf of Mexico oil platforms (Thunderhorse and Atlantis), or by a small fraction of California and Alaska production."[23]

If the supply of crude oil for DoD requirements is not in question, how to pay for it is. During the past few years the President has requested supplemental funding to cover the increased cost to the DoD to cover operations around the world for the war on terror. This supplemental funding has allowed the Services to essentially operate at the current tempo without regard to the cost of oil. While the DoD is certainly interested in the reduction of energy usage, there have been no draconian steps taken to reduce oil consumption by limiting the use of jet fuel. However, if the cost of jet fuel were to increase eight fold as hypothesized earlier then it would be likely that significant changes in jet fuel usage would have to be considered. Just as the DoD would be dealing with crude oil prices of $500 dollars per barrel, so would the nation as a whole, and therefore, unlikely that the President would be able to simply request a "supplemental" budget to cover these increased costs.

So if the President is unable to get a "supplemental" budget approved then the Navy/Marine Corps TACAIR would be forced to operate within its allotted budget. As the "price change memorandums" start coming from the DoD indicating higher jet fuel prices then the hard decisions would begin. With no top line funding relief provided then this increase in jet fuel cost would have to be funded internally to the Navy's budget by:[24]

1. Reduced Procurement
2. Reduced Manpower
3. Reduced Maintenance
4. Reduced Flight Hours

Each of these options will be looked at in the short and long term to examine its applicability in providing relief for the increased cost of jet fuel.

The option of reduced aircraft procurement would be very challenging in the near term as contracts have been set and production has begun. However, over the long term reduced procurement would allow additional funds for jet fuel. The U.S. Navy's Aircraft Procurement budget is the 10% of the overall Naval budget and the fourth largest budget line number behind Operations and Maintenance, Military Personnel, and Research, Test and Development.[25] There are significant risks accepted when delaying aircraft procurement however. As the fleet of aircraft ages they become more obsolete as technology advances and there remains the inevitable requirement to purchase new aircraft. The aircraft will also become more expensive to fly as depot level maintenance requirements increase and the aircraft simply break more often because of their age. The option to delay the purchase of aircraft to fund additional fuel cost maybe even less of an option when the Navy has already used this tactic to reduce their overall budget by significantly reducing aircraft procurement during the DoD budget draw down in the middle/late 1990s.[26] With these concerns it appears that a reduction in aircraft procurement would not be an option in the near term and the long term effects of reduced aircraft procurement would cause problems on an even larger scale that an increase in jet fuel cost.

The DoD budget draw down post 1991 not only affected aircraft procurement, but also service manning. The manning reduction in the Marine Corps and Army after the 1991 Gulf War combined with heavy deployments to support the war on terror has made it essentially impossible to reduce the size of the forces to compensate for any increase in

the cost of jet fuel. In fact, both the Marine Corps and the Army have been authorized end strength increases due to the increase in op-tempo caused by the war on terror. No increase in personnel comes cheap, as Frederick Kagan writes in *Foreign Affairs*, where he finds that the average cost for a service member is $112,000 per year and increasing every year.[27] The U.S. Air Force is continuing its force drawn down to 326,000 Airmen by the end of FY '08[28] to allow it to pay for the 175 F-22's it desires to buy. For every 3,000 Airmen the Air Force reduces its end strength by it will be able to buy one additional F-22.[29] The option to reduce manning to support the increased cost of jet fuel is not very viable due to the concerns listed above and would also be in direct conflict with the idea that current and future wars will be manpower intensive.

The remaining two options (reduced maintenance and flight hours) are interrelated in that by reducing flight hours the Marine Corps would be able to reduce maintenance cost. Simply reducing maintenance cost by reducing the amount of parts that are purchased to repair broken aircraft would save money but would also result in few flyable aircraft and therefore the Marine Corps would see a reduction in flight hours. Currently maintenance costs consume about 74% of the average CPFH for Navy/USMC TACAIR.[30] The option of reducing maintenance cost by sliding depot level maintenance to a later date is also available. This would provide some near term relief if the fuel price increase was to be short term, but you are essentially just pushing the cost of maintenance further down the road. Another possible way to reduce maintenance cost would be to reduce the manning in the squadrons' maintenance departments. This would have the essentially the same effect as reducing the number of parts bought, fewer maintainers equals fewer repaired aircraft and therefore, a reduction in flight hours.

What these previous three paragraphs lead to is that realistically the only way to reduce the cost of aircraft operations in the short term (up to two years) is to reduce flight operations, therefore, keeping the cost of USMC TACAIR aviation at the same level (CPFH goes up, however, there is a corresponding reduction in flight hours). The normal budgeting process would hopefully allow the DoD/DON to adjust to the increased cost of jet fuel and therefore, the increased cost of flight operations in the long term. The Iran/Venezuelan scenario described earlier that brought us to this situation might resolve itself. The biggest risk lies with the possibility that kinetic operations might be required in the near term during a period of possible reduced flight operations. What are the effects of reduced flight operations on Marine Corps TACAIR squadrons (F/A-18, AV-8B, and EA-6B) and the 2nd order effects on the rest of the Marine Corps in general, and even more important what does this cost the Marine Corps in capability?

Earlier in this paper I determined that the increase in jet fuel cost due to $500 crude oil cost per barrel would result in an eight fold increase in jet fuel cost with 182% increase in the average CPFH for Marine Corps TACAIR. With this 182% increase in the cost to continue to fly TACAIR and the requirement to maintain a balanced budget would require a 54% reduction in flight hours. The Marine Corps is currently funded to keep their squadrons at a Core Competency Resource Model (CCRM) T-2.0. Per MCO 3125.1A (Marine Corps Flying Hour Program (FHP) Management) T-2.0 will enable a "unit to fulfill its unit core capability statement to support a Marine Air Ground Task Force or joint force commander."[31] The 2007 Marine Corps Aviation Plan has the following flight hours per month required to maintain T-2.0 by T/M/S: (F/A-18A+/C 19.2), (F/A-18D 20.9), (AV-8B 13.9), and (EA6B 21.6).[32] Thus a reduction in the flight

hour program below what is required to maintain T-2.0 would directly inhibit the ability of Marine Corps TACAIR to support the MAGTF.

Marine Corps TACAIR would have to examine ways to minimize the potential risks that reduced available flight hours would have on TACAIR's ability to properly support the MAGTF. The possibility that every TACAIR squadron would be required during this period of reduced flight hours is very unlikely and so TACAIR leadership could shift flight hours to ensure a certain percentage of squadrons or pilots remain properly trained and combat ready. Some flights could be flown with simulators; however, only two F/A-18 simulators exist in Beaufort for example, and even if these two simulators operated 24 hrs/day they would not be able to even touch the requirement.

The direct loss of combat capable TACAIR squadrons would be a significant first order effect due to the loss of flight hours, but the effects don't end there. How many FAC's/JTAC's would lose Training and Readiness (T&R) currency/proficiency due to the lack of FW CAS sorties available to train with? There would not be enough FW CAS sorties to train new FAC's/JTAC's so the impacts would not only affect TACAIR but would begin to affect Marine battalions and regiments as well. What would happen to all the pilots not flying while the Marine Corps attempts to keep certain pilots combat ready? These pilots not flying would not be able to simply start flying again when more flight hours would become available but would have to be retrained and this would eat up a tremendous amount of available sorties. Imagine trying to adjust squadron deployment schedules to ensure that you would have the minimum capability forward deployed so that you could keep that ready reserve available to the MAGTF commander. The flight hours programmed are essentially the minimum required to maintain T-2.0 for the

number of squadrons required to support current and potential OPLAN requirements and therefore, any loss of flight hours is going to have a negative effect on the ability of Marine Corps TACAIR to support the MAGTF.

A possible future global oil crisis that causes $500 per barrel crude oil which in turn causes $16 per gallon jet fuel would result in a reduction in flight hours available to Marine Corps aviation; therefore, the Marine Corps must examine ways to minimize our exposure to a dramatic increase in crude oil cost.

The recent increase in the cost of crude oil and its possible effects on national security and national defense has not been ignored by the DoD. Two recent studies have been published addressing the DoD's reliance on fossil fuel and possible alternatives. In the spring of 2006, the Director of Defense Research and Engineering (DDR&E) led a task force charted with examining the issue of energy security, devising a plan for lowering DoD's fossil fuel requirements, identifying alternate energy sources and examining past and ongoing studies to help define DoD's options.[33] The task force presented the following findings.

1. Increase platform efficiency.
2. Accelerate installations' initiatives.
3. Establish alternative fuels programs.

In September 2006 the JASONs released their report "Reducing DoD Fossil-Fuel Dependence." Due to the increasing U.S. dependence on foreign oil, rising fuel costs, and national security issues, the JASONs were charged by the DDR&E with assessing ways to reduce the DoD's dependence on fossil fuels. The JASONs provided the following findings and recommendations: [34]

1. No extended world-wide shortage of fossil-fuel production is reasonably expected over, approximately, the next 25 years. This finding is premised on the assumption of no major upheavals in the world, in general, and in the major oil-producing nations and regions, and oil-transportation corridors, in particular, over the next 25-year period.

2. The 2006 DoD fossil-fuel budget is approximately 2.5-3% of the national-defense budget and only recently have fuel costs become noticeable to the DoD.

3. DoD is not a sufficiently large customer to drive the domestic market for demand and consumption of fossil fuel. Non-fossil-derived fuels are not likely to play a significant role in the next 25 years. Present fuel-from-biomass processes do not compete with fossil fuels.

4. The compelling reasons to minimize DoD fuel use:

a. Fuel costs represent a significant portion of the life-cycle costs of mobility platforms.
b. Fuel use is characterized by large multipliers and co-factors: at the simplest level, it takes fuel to deliver fuel.
c. Fuel use imposes large logistical burdens.
d. Anticipated and already imposed environmental regulations and constraints.
e. An unpredictable future makes it advisable for the DoD to minimize its exposure and vulnerability to potential unforeseen disruptions in crude oil supply.

The findings and recommendations provided above provide a place to begin to minimize the Marine Corps' exposure to a dramatic increase in the cost of crude oil. The Marine Corps faces significant challenges to reducing the amount of jet fuel consumed by Marine Corps TACAIR. Unlike mobility aircraft (C-5, C-17, C-130, etc), the option to re-engine or place winglets on the wings of TACAIR aircraft does not exist. Bio-fuel is not an option for aviation[35] and the processes Coal-to-Liquid (CTL) fuel and Gas-to-Liquid (GTL) have significant drawbacks that will be difficult to overcome, particularly the lack of sulfur which reduces the amount of lubricity in the fuel and sulfur helps the engine's seals swell to keep fuel/oil from leaking.[36] Another option may be to look at how we execute flight training to begin with.

An interesting consulting report was completed by Capt Jeremy Howe and Capt Kevin Dawson, USAF, to evaluate the idea of reducing the average sortie duration (ASD) of each flight to reduce the number of flying hours accrued, therefore, reducing the amount total flight hours flown.[37] This report was requested due to F-15C/D maintenance issues that were causing fewer aircraft to be "up" and not available for pilot training. When the analysis was complete the report found that "CPFH will increase as ASD decreases, irrespective of the amount of sorties or hours flown."[38] Therefore, we can conclude that if an effort was made to reduce cost by flying shorter flights, yet attempt to get the same training, it would still cause an increase in the CPFH and therefore would not help the situation.

The Marine Corps' TACAIR aircraft can not use alternative fuels, re-engine their aircraft, install winglets, or adjust their sortie lengths in an effort to reduce jet fuel consumption. Therefore, the Marine Corps' hands are tied to the jet fuel requirements of its current aircraft and to include the JSF, F-35 Lightning II. Again, the Marine Corps' only future TACAIR aircraft will not be able to take advantage of fuel conservation practices except for simulation. There has been no information published indicating the number of flight hours per month F-35 pilots will be required to fly to maintain T-2.0 status and what percentage of them will be simulated hours. Therefore, any disruption in jet fuel prices that warrant a reduction in flight hours will degrade TACAIR's ability to support the MAGTF and another approach is required if the Marine Corps desires to reduce its risk to jet fuel prices.

The JASON report found that "among the DoD unmanned vehicles, UAV's represent the most mature technology, benefiting from decades of development of

autopilot systems in manned aircraft."[39] The JASON report found that UAS's can result in fuel savings of approximately 97%, or a fuel-saving factor of 30.[40] Currently the Marine Corps is in the process of transitioning from the RQ-2B Pioneer to the RQ-7B Shadow.[41] The Shadow will provide 16 hours of loiter time while burning only approximately 15 gallons of jet fuel. The follow UAS to the Shadow is the Vertical Unmanned Aircraft System (VUAS) and is expected to IOC in 2015.[42] While the VUAS will be an improvement over the Shadow and will provide excellent battlefield situational awareness, it still will not be able to replace the striking power of Marine Corps F/A-18's or JSF's.

The Marine Corps does not have any appreciable way to minimize its reliance on jet fuel if it intends to maintain its striking power. This very point must be acknowledged so that future steps can be taken in our training and acquisition programs to minimize our dependence on jet fuel. Tactical aircraft are not suitable for future fuel efficiencies and UAS's do not bring the striking power required to replace tactical aircraft. The potential for a dramatic increase in the cost of jet fuel remains unlikely, but it should be clear that the Marine Corps truly has no way to avoid the repercussions of such and degradation in Marine Corps TACAIR should be expected. The Marine Corps must understand and acknowledge its jet fuel dependence and only then will the emphasis be placed on reducing this dependence.

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