The Physiological Impacts of Global Attack on Aircrew Performance

A Monograph
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MONOGRAPH APPROVAL

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ABSTRACT

THE PHYSIOLOGICAL IMPACTS OF GLOBAL ATTACK ON AIRCREW PERFORMANCE by MAJ Patrick W. Christopherson, USAF, 45 pages.

The Air Force's ability to execute global attack is critical. The Air Force markets global attack as a key contribution to the nations military effort. The execution of global attack, partly necessary because of the decline of total force structure and worldwide bases, has put substantial stress on the Air Force's airmen.

This monograph analyzes the physiological impacts that global attack execution puts on airmen. Beginning with an introduction to the doctrine and history, the monograph explains the evolution of global attack doctrine and the history perspective it evolved from.

Having outlined the history and theory, the monograph looks at the most recent and profound example of global attack, Operation Allied Force. The B-2 "Spirit" bomber missions from Missouri to Kosovo and back provide a unique opportunity to analyze the adverse physiological impacts on the airmen. A focus on aircrew performance related to stress, fatigue, sleep deprivation, and adjustments to work-sleep schedules indicate the level of preparation and reveal the challenges they encountered. The ultimate goal is to determine if aircrews are prepared for the physiological affects they encounter during the execution of global attack. Additionally, it provides insight into the ability to counter the adverse affects and makes the lessons exportable to future Air Force missions.

The study concludes that the Air Force did a suitable job of preparing its airmen for combating the physiological challenges. However, contrary to the claims of Air Force brass, the physical limits of global attack appear to have been reached. Future missions will require improvement in a number of areas physiologically impacting airmen. A list of topic areas applicable to global attack's future mission success concludes the monograph.

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"I don't even start to get concerned until we get closer to 40-hour missions"[1]

-Brig. General Leroy Barnidge
Commander 509th Bomb Wing

I. Introduction

Background and Significance

The Air Force's ability to execute global attack is critical. Air Force Doctrine Document 1 (AFDD-1) heralds global attack as one of its six core competencies. According to AFDD-1, core competencies "are at the heart of the Air Force's strategic perspective and thereby at the heart of the Service's contribution to our nation's total military capabilities." The Air Force markets global attack as a key contributor to three of the four Joint Vision 2010 concepts enabling full-spectrum dominance. Global attack is mentioned as an integral part of dominant maneuver, precision engagement, and full-dimensional protection[2].

The increase in the number of Air Force commitments combined with a decline of both total force structure and worldwide bases have dramatically increased operations tempo[3]. These facts combined with the Air Force's claim of rapid global mobility and capabilities characterized by Brig. General Barnridge's opening quote put substantial strain on Air Force systems and airmen[4]. In spite of the challenges, the Air Force has accomplished its missions admirably. Operation Allied Force is the most recent

example of United States military success. The triumphant execution of global attack, epitomized by the B-2 Spirits employment from Whiteman Air Force Base (AFB) to the skies of Kosovo, does not come without cost. The airmen who execute the missions are under intense pressure to perform while facing profound physiological challenges. Subsequently, this monograph examines how well the Air Force prepares its aircrew for global attack missions. A focus on aircrew performance indicates the level of preparation and reveals the challenges they encountered. The ability to adapt to the new challenges is a secondary objective. The ultimate goal is to determine if aircrews are prepared for the physiological affects they encounter during the execution of global attack.

The need to objectively address the areas of concern is essential for several reasons. First, to ensure the Air Force is not putting an inordinate amount of stress on the aircrews, jeopardizing their safety. Second, to apply the lessons and successful implementation to future missions. Finally, to ensure future funding for these invaluable assets is still justifiable.

II. Methodology

The United States Air Force has firmly committed its valuable assets towards the accomplishment of one of its core competencies "global attack". For this reason, an

understanding of the doctrine, the requirements for execution, and the reliance of its successful implementation to the joint fight are critical. Therefore, Chapter one introduces global attack doctrine and discuss its importance. Chapter two describes the methodology for research and the methods of presentation. Chapter three provides a footing for understanding the doctrine and its significance, while providing historical insight into the doctrine's evolution. Chapter four analyzes the results and assesses Air Force preparation and pilot adaptation. Chapter five provides recommendations for future improvements and concludes the monograph.

To produce these chapters an extensive search for sources was necessary to determine the magnitude and quality of information available. The initial research and topic familiarization centered on the subject areas surrounding global attack and the physiological affects that influence aircrew performance. The research indicates no such definitive source exists that attempts to study the link or affects that either global attack and aircrew performance may have on each other. Fortunately, the seventy-eight day air operation over Kosovo in the spring of 1999 provides excellent sources for research.

Operation Allied Force furnishes a unique and timely opportunity to assess doctrine in action. The B-2 Spirit's

missions emanating from Whiteman AFB, Missouri to the skies of the Former Republic of Yugoslavia (FRY) tested the full capabilities and limits of global attack. The uncommon challenges this conflict placed on airmen offers a grand opportunity to review the physiological affects airmen encounter during execution of this core competency. Specifically, stress, fatigue, sleep deprivation, and adjustments to work-sleep schedules are physiological items of interest. These items, which have historically influenced aircrew performance and additional areas that surfaced during the investigation, round out the analysis. Interviews of airmen and others associated with the event, and on-site observations are the primary methods to investigate the relationship of global attack execution and the physiological influences on aircrew performance.

The interviews at Whiteman AFB were selected as a primary source because of the recent nature of the event and the overall lack of published material on the topic. The interviews focus on aircrew mission execution and their adaptability to the physiological challenges. The investigation provides insight into the ability of the airmen to counter the adverse affects. Ultimately, the Air Force's preparation of its aircrews is examined. Aircrew performance was selected because it is a key enabler for the mission. A consensus among the score of interviewees was

that it was one of, if not the weakest link during the execution of the global attack missions[5]. Thus, this researcher concentrated the interviews on historical and peripheral physiological inhibitors that materialized during Operation Allied Force. The methods and means to adapt to the performance inhibitors completes the research and analysis section of Chapter three. The interviews covered a broad base of pilot experience. The aircrews, all on at least their second assignment, represented the entire spectrum of Air Force fighter and bomber aircraft. Many of the pilots have previous combat experience and have flown other global attack missions of shorter duration in other aircraft. The diverse background helps validate the exportability of the B-2 results in Operation Allied Force to other airframes and scenarios.

The analysis of the affects of performance inhibitors, assessment of their affect on airmen, the Air Force's ability to prepare the airmen, and the means the airmen develop to successfully overcome them is the attention of Chapter four. In this section, the secondary research questions are answered. Specifically, the chapter asks are the Air Force systems and training postured to reduce adverse human physiological impacts and did the environment foster the agility and initiative necessary to counter the unknown human physiological inhibitors that were certain to

transpire? The ability to recognize the problem areas, aggressively counter any degradation they might inflict, and the capability to export the methods to other global attack missions is where this monograph provides value to the Air Force. Additional recommendations for research and study of one the Air Force's core competencies--global attack, as well as concluding remarks, complete the monograph in chapter five.

I. Research and Analysis

Review of Doctrine

"At 0200 local time on the morning of 17 January 1991, airmen from all military services and ten nations became the "thunder and lighting" of Operation Desert Storm…Literally in minutes, the coalition delivered a knockout blow to Iraqi air defenses and paved the way for thousands of air sorties to pummel Iraqi leadership, their command and control capabilities, essential services, infrastructure, and military forces. After only twenty-eight days, the Iraqi army in Kuwait and eastern Iraq was now demoralized, disorganized, and degraded that coalition surface operations envisioned to require weeks took only days."

-Colonel Edward C. Mann III[6].

Aerospace doctrine is a relatively new area considering the evolution of military doctrine as a whole. The enactment of the Goldwater-Nichols Act of 1986 and subsequent emphasis on joint warfare provided the spark to articulate and publish the services statement of officially sanctioned beliefs[7]. The recognition of the importance of the trend towards joint operations, the increased competition for diminishing defense dollars, and the vision

to leverage its unique abilities motivated the Air Force to meld its doctrine with Joint Vision 2010 and future warfare.

The Air Force developed its own 'principles of war' it calls the tenets of air and space power that uniquely describe its particular capabilities and employment axioms[8]. Core competencies form the cornerstone of the doctrine. The Air Force defines a core competency as a basic area of expertise or specialty that it brings to the spectrum of military operations[9].

Global attack is one of the six core competencies encompassing both speed and a global span. This unrivaled Air Force strength has recently come of age with the successful employment of the B-2 in Operation Allied Force in Kosovo. The validation of the doctrine was an important step to confirm Air Force efforts and sometimes-controversial expenditures, are heading in the proper direction.

Historical Basis

The origins of global attack began early in the evolution of air warfare. Advances in technology and their implementation into capabilities eventually allowed this vision to become reality anywhere in the world. During the Vietnam War, several developments displayed the potential of global attack. The use of air-to-air refueling (AAR) matured allowing extended ranges that reached well beyond a

nation's borders. Additionally, precision guided munitions (PGMs) emerged laying the bedrock for the one bomb, one target mentality expectation now common among Air Force fighter pilots. It was during Vietnam War era that the airman who eventually proclaimed global attack as a core competency were gaining experience and formulating ideas for the future when they were to lead the Air Force.

Arguably, in 1983, during Operation El Dorado Canyon, was the first time that global attack was implemented. Operation El Dorado Canyon was a five-thousand-nautical-mile mission from Upper Heyford Air Base England to Tripoli via the Straits of Gibraltar[10]. The U.S. attack was an effort to confront international terrorism and to make a statement that the U.S. would not stand for terrorist attacks against its citizens or soil. An armada of twenty-four F-111s and support aircraft made a long-range voyage to link up with naval assets for a joint assault on Muammar al-Qaddafi's headquarters. The mission's length was doubled due to political restrictions prohibiting overflight of France and Spain. This external influence forced a course of action (COA) that made the Air Force use its full capabilities. The first global attack mission pressed the machines' technological, and mans' physiological limits.
The tactical and strategic success of Operation El Dorado Canyon is debatable. The bomb results were less than

expected but they did seem to silence Qaddafi's regime in the ensuing years providing some validation of mission success[11]. The debate over the application of military force in this scenario is beyond the context of this paper. However, simply having the ability to apply military means as an option, via global attack, was a unique event in our nation's history.

Considerable obstacles, both political and physical, were overcome to implement Operation El Dorado Canyon. The unprepared Libyans admitted they were caught off guard from the U.S. Air Force attack staged from Britain[12]. Operation El Dorado Canyon demonstrated the Air Force's ability to project power over global distances in a rapid manner forming the foundation of this core competency[13]. The Air Force has refined this idea, as the B-2 missions demonstrate.

Global Attack in Kosovo

"This thing (Operation Allied Force) has changed History"[14].

-Brig. Gen. Leroy Barnidge Jr.
Commander 509th Bomb Wing Commander

Nearly every evening B-2 Spirit bombers took off from their safe haven at Whiteman AFB Missouri and headed east on a thirty-hour 14,000-mile journey into combat over the FRY[15]. Avoiding enemy air defenses and employing 2,000-pound bombs on up to sixteen desired mean points of impact (DMPI), the missions were highly successful. The sorties

vindicated the ten years of flight testing and performance expectations for the most expensive weapon system in the world[16]. The B-2s flew only one percent of the total sorties yet accounted for eleven percent of all the targets destroyed. According to the Air Force Times, the B-2 firmly established global attack as a proven competency and invented a kind of "commuter war"[17].

Global attack profiles are now possible by numerous airframes however, B-2 experience accentuates the outer limits of this capability subsequently highlighting the good and bad that comes with it. It also illuminates the physiological challenges airmen face during mission execution. A look at typical mission profiles provides insight into the physiological accomplishments fulfilling a global attack mission.

Lt. General Marvin Esmond characterized the B-2 mission profile as, "twenty nine-and-half hours of boredom surrounded by thirty minutes of sheer terror"[18]. The aircraft took off during the late evening or early morning hours and headed east towards Newfoundland Canada. The profile over the United States was benign and resembled that of an airliner. Somewhere over the Atlantic the "Spirit" rendezvoused with a cell of Air Force KC-10 Extenders or KC-135s for the first of four AARs. Thirty minutes prior to each AAR both aircrews manned their positions and prepared

for refueling. For many of the pilots, the AARs represented the greatest flying challenge of the mission. Requiring hands-on flying the whole time, each AAR lasted between twenty and forty-five minutes. The aircrew often split flying the aircraft assisting each other as necessary. The AARs were separated by approximately six hours. After the AAR, the B-2 left the tankers and flew in a vertically confined sanctuary block of airspace set aside to deconflict with civilian traffic over the Atlantic Ocean. The voyage to the shores of Western Europe lasts about six hours.

Approaching the Straits of Gibraltar the pilots again rendezvoused with tankers and refueled prior to heading into the Mediterranean towards their targets in the FRY[19]. The radios were a problem during this portion of the mission. Often it was difficult to contact international controllers to communicate intentions or receive instruction. Entering the "Straits" the final mission inputs were also received with varying degrees of success. Surprisingly, the B-2s radios are no more advanced than airframes a fraction of their cost. At some point over the Mediterranean, the B-2s "disappeared" at their scheduled destination. Prior to flying into the FRY the stealth bombers crew made last minute timing adjustments, confirmed go-no-go items and ensured suppression of enemy air defenses (SEAD) support were in place to reduce the risk of detection[20]. The B-2s

typically carried sixteen 2,000-pound satellite guided munitions and serviced several distinct targets. The near precision ordnance was released from an altitude of over five miles high on stationary targets usually of strategic importance and critical to the enemy war effort. No B-2s were shot down nor obtained any battle damage from external systems[21].

Once the ordnance was expended, the B-2s navigated on route minimizing the egress threat exposure until back over international waters. After exiting FRY, the B-2s magically "reappeared" with Italian air traffic controllers and headed for a refueling contact point.

Consisting of over 100,000 pounds of gas, the forty-five minute post-target AAR was the longest most of the pilots ever experienced in peace or wartime. When this refueling was complete and the target area adrenaline subsided, exhaustion set in. The trip back across the Atlantic was long and tiring. The last AAR occurred twenty-four hours after takeoff. As the B-2 crossed into United States air space the airline procedures resumed and in every case, the B-2s safely returned to Whiteman[22].

The typical crew day began with a telephone wake call from the squadron's senior duty officer of the day otherwise known as the "top three". The phone call was expected but the time was unknown due to the flexible nature of the Air

Tasking Order (ATO). The recall's message did not expand on the extent of the day's tasking so one could not be sure if it was their turn to fly, be the spare, or mission plan. The exact tasking was not clarified until arrival at the squadron. In either case, the prudent aviator had his gear in place and full-sized cooler packed with a forty-hour supply of food so he could arrive at work within a mandated recall window. Once at the squadron the pilots reported to the top three, signed in and received their tasking for the day[23].

The B-2 squadron used a three-day cycle to prepare for missions. The first day educated the aircrews on tasking they could expect later in the cycle. Additionally, pilots studied the special operating instructions (SPINS), reviewed intelligence reports, got acquainted with survival procedures and equipment and flew a target area simulator practicing weapon employment procedures in a realistic scenario. The simulator consisted of a representative mission profile and target array emulating the situation in FRY. Occasionally, the simulator was the first time the two-man aircrew flew together so they familiarized themselves with crew coordination procedures and discussed specific concerns they had with mission execution[24].

Finally, the pilots assisted with the mission planning for the next day. The mission planning process allows the

pilots to gain familiarity with the route, procedures, refueling information, target area threats, and other pertinent information essential for successful mission accomplishment. The result of the mission planning process was a flight ready packet of maps, cards, and digitized computer information that enhanced the aircrew's chances of putting bombs on target[25].

On the second day of the cycle the pilots served as the ground spare. They attended all of the pre-flight briefs and went through the entire five-hour pre-flight process to include suiting up in full combat gear and aircraft ground operations. The option of taking off as an air spare also existed. This process served as an excellent rehearsal. On several occasions the spares ended up replacing the missions that were originally scheduled. This was primarily due to maintenance factors. If the aircrew were not used as the spare they entered crewrest and awaited the recall the next evening. On the third day, the pilots had a good idea it was their day to fly. They repeated the previous day's procedures, further familiarizing themselves with the mission materials focusing on target area execution. The final targeting data was often the only change from the preliminary targeting information the pilots received from the B-2 ATO liaison[26]. This was key as late dissemination of the ATO did not provide sufficient time to study all the

mission materials. The late dissemination of the ATO is one example of a performance inhibitor, the topic of the next section.

Common Aircrew Performance Inhibitors

Aircrew performance can mean a variety of things to aircrews of specific platforms however, there are common threads that relate to most airmen. One measure of aircrew performance is the ability to safely take-off, perform the assigned mission and land the aircraft. The second criterion relates to the degree that the assigned mission was successfully completed[27]. For the B-2 missions, getting to and from the target and safely landing at Whiteman, after delivering all the bombs on the proper target, defined the standard aircrew performance required[28]. Understanding aircrew performance is critical as are the physiological matters related to the subject.

Agencies and individuals concerned with aircrew performance have performed numerous studies pertaining to physiology matters involving airmen. The definition of physiology of interest pertains to the healthy functioning of an organism[29]. To draw one clearly defined and universally agreed upon list of physiological factors that adversely influence performance is difficult. With some confidence of agreement, the four physiological factors of fatigue, stress, sleep deprivation, and disruptions to the

human biological clock seem to make most lists[30]. This list forms a launching point to review the stresses placed on aircrew during the execution of global attack. A review of aircrew inhibitors is necessary to build on the common reference.

According to Websters, fatigue is weariness from labor or exertion[31]. Additionally, fatigue is a state of feeling tired or sleepy that results from prolonged mental or physical work, extended periods of anxiety, exposure to harsh environments, or loss of sleep. Boring or monotonous tasks can increase feelings of fatigue. Indicators of fatigue that might be noticed by airman include difficulty in attention and concentration, a dull and sluggish appearance, carelessness, or irritable behavior[32]. Often these characteristics emerged as exhaustion set in after the post-target area adrenaline ceased or during the third and longest refueling. The preparatory training did not accurately simulate these events. Long simulators were flown and 100,000 pound fuel off-loads were received, but never on an actual flight or more than a half-day after takeoff. Often the B-2 pilots recognized the cumulative fatigue of the flight during the long AAR or around the twenty-four hour mark[33]. In the next example, cumulative fatigue was a direct contributor to the overall stress level.

During the ocean crossing, the artificial requirement to remain within the relatively low and restricted flight corridor impacted the aircrews. Established to deconflict from civilian traffic, the corridor was not designed for B-2 performance considerations or for weather avoidance[34]. Weather is a major concern for any flight and the pilots are aware of the perception that stealth aircraft are particularly sensitive to it[35]. The restrictive corridor increased pilot actions, added to the pre-target flying fatigue, and minimized options to best handle adverse weather.

Stress is the state of being strained by events to the extent that ability to adapt and respond is difficult or impossible. According to the Leader's Guide to Crew Endurance, "Chronic stress contributes to an individual's overall level of fatigue, and acute stress can worsen already existing fatigue-related problems." The guide adds that stress can produce physical complaints, headaches, gastrointestinal upset, increased blood pressure, and decreased ability to fight off infections and disease[36].

At first glance, the single largest contributor to stress should have been the time in the target area when the aircrews were most vulnerable. The majority of the pilots indicated this was not the case. Many mentioned the AARs as the most stressful event. One seemingly calm but

inexperienced B-2 pilot explained of a constant nervous sensation during the AAR procedure. He was not comfortable during the entire time he refueled. His training was the only thing keeping him focused. Other B-2 pilots, many with single-seat fighter experience concurred, explaining the difficulty of refueling the Spirit in the dark for up to one-hour at a time. They stated it was a more stressful than refueling fighter aircraft they had previously flown[37].

Due to the dominant nature of the air campaign and the success of stealth, the target area employment was not the most stressful event. The greatest stress was not from the typical sources such as enemy fire or air combat engagements, but from internal and external pressures to succeed, the intolerance for mistakes and in general, the high visibility of the missions. The target area stress often began prior to takeoff. The late delivery of the mission planning materials did not allow adequate time to study the DMPIs. This prevented the ability to ask clarifying questions[38]. This also required the pilots to spend portions of their in-flight time, previously allocated for sleep or rest, analyzing target information.

Sleep deprivation is the denial of physiological need for sleep outside of the norms. The average sleep duration for humans is from seven to nine hours. Any variations from this quantity can produce negative effects of varying

magnitudes[39]. An isolated refusal of scheduled sleep or a persistent prohibition of more than five hours of sleep a day for sustained periods meets the definition of sleep deprivation. Sleep deprivation can have the same symptoms as fatigue or stress or it can compound problems in environments that produce other stresses. The variance on the amount of sleep pilots obtained in flight varied considerably. The range was from two to eight hours with a median of six hours. The longest single session indicated was six hours and usually the sleep was accumulated over two to three sessions occurring in-between the AARs. In most cases the pilots indicated a disruption in their sleep occurred during the recall and several mentioned that they could not sleep during their crew rest window as it was outside their normal sleep patterns[40]. In general, the two days prior, the day of the flight, and the day after the flight involved abnormal sleep patterns for most of the interviewees.

The symptoms of disruptions in the human biological clock are similar to all of the other aircrew performance inhibitors previously discussed. Shift lag and jet lag are two phenomena influencing performance. Shift lag results when a transition in the work schedule occurs. For example, the movement from a day work schedule to a night work schedule in a mission-planning cell might induce shift lag.

Jet lag is associated with the rapid travel across time zones and the subsequent changes to the sleep and work schedule[41]. Either lag, individually or simultaneously are factors identified as potential problems.

Aircrews were put on schedules to enhance their performance for the early morning takeoffs. After a week, the sleep cycles were modified to heighten alertness in the target area fourteen hours after takeoff. It became apparent that twenty hours from show time to the target area was not optimizing pilot performance. The adjustment directed one pilot to sleep immediately after takeoff so he woke up feeling refreshed in the target area[42]. This change went against all the Air Force paradigms of crew rest but proved successful. The necessity and discipline required to stagger aircrew performance levels during the marathon mission was essential for mission success. The ability to recognize all the common stresses was key but there were other physiological inhibitors contributing to the problems the Air Force and aircrews needed to overcome.

Additional Physiological Inhibitors

Besides the traditional physiological challenges of fatigue, stress, sleep deprivation and human clock interruptions, other areas of concern surfaced during the B-2's execution of global attack. In fact, all of the aircrews mentioned some specific incident getting to, or

from the fight that added to their workload, stress level, or fatigue.

Whiteman's geographic isolation provided time and distance barriers limiting effective coordination. The integration of B-2 missions into ATO cycle highlighted this challenge. The seventy-two hour ATO cycle often did not get final target approval until well into the last twenty-four hours. Many of the delays were due to factors outside the ATO's control. Regardless of the reason, the responsiveness was too slow for the B-2 mission planners. The B-2, like most Air Force combat aircraft are dependent on the Air Force Mission Planning System (AFMPS). The AFMPS allows mission planners to program the route, threat, and most importantly, target information into the jets software for employment. The system is a great enabler in flight and is essential for mission success. AFMPS requires substantial ground effort to accurately use. The late target notification, often less than four hours prior to take off, put undue stress and pressure on the mission planners and aircrew[43].

The aircrew occasionally did not have mission materials to brief from until after their scheduled briefs. Experienced pilots noted how this obstacle added unnecessary chaos to the already heightened situation. The briefs also were influenced by geographic separation. The direct

coordination available in face-to-face or telephonic briefings was obviously lacking. Aircrews expressed concern over the coordination with Suppression of Enemy Air Defense (SEAD) assets[44]. The ability of the B-2 to remain stealthy during its highly vulnerable weapons delivery time is sometimes conditional on SEAD success[45]. Often, the SEAD coordination did not get much deeper than the few lines in the ATO. By design this was usually adequate but it assumes system familiarity and previous training which was not the case. None of the interviewees indicated previous B-2 training with SEAD assets and the B-2 aircrews' system knowledge of SEAD doctrine was admittedly low[46].

The majority of time and distance with each global attack mission involves getting to and from the war zone. During this time complaints about adhering to highly regulated peacetime air traffic control measures were common. These measures include filing a flight plan with the Federal Aviation Administration (FAA) which reveals the number and type aircraft, flight location, and flight duration. The broadcasting of this information via unsecured channels many hours before the time of targets dumbfounded the aircrews[47]. Furthermore, the attempts to use tactical deception were squelched due to administrative impossibility. The use of deceptive call signs and flight information on common airline channels caused sufficient

controller confusion and additional pilot strain to deem the deception efforts as "not worth the headache"[48]. The controller problems continued in the overseas environment where the pilots, whom were not used to operating under international air traffic control, experienced difficulty communicating their intentions and taking directions. Besides the stress involved with this administrative portion of the flight, anyone monitoring the published radar control frequencies could get a 30 minute warning to the B-2s arrival removing the surprise they are dependent upon[49].

Back at home there were additional areas contributing stress to the aircrew performance equation. Concern over maintaining the privacy of the B-2 aircrews was one area. The pilots expressed anxiety for the safety of their families. It was brought to their attention how the Internet could be used as a tool to stimulate reprisals against aircrews the net users were able to identify. The aircrew and their families knew it was a relatively easy to identify them as they were so few in number, and have ready access to their unsuspecting family members[50]. Despite several minor demonstrations in the pro-military community, there were no recorded acts of retribution against any airmen. The security of the families brings light upon the larger issue of operations security (OPSEC).

When combat operations are sustained from a deployed location, the physical barrier between the families and communities provides a substantial buffer to some of the more vulnerable nodes of OPSEC. The local community is exposed to daily operations and has access to more damaging information than many of them are aware of. Individuals or organizations attempting to gain such information against the United States could find these local sources as ripe targets. Again, there were no reported instances at Whiteman AFB however, there was a conscience effort to minimize the local changes due to the combat operations. In fact, Captain Mel Deili, an officer assigned to the bomb wing noted, "it appeared as if most people did not know a war was still going on after the press barrage of the first few days"[51]. This was in part because of the community's familiarity with the B-2 and its mission. Interestingly, this represents one of the side effects of the global attack mission. The physical separation from the combat environment combined with the simulator like mission execution, allows the airmen and support personnel to distance themselves from the realities of combat presenting a business as usual environment.

Going to combat directly from ones home base offers other unique challenges. Since pilots were not physically removed from their routine peacetime environment, adjustment

was necessary to refocus their efforts. The inability to mentally remove themselves from the routine additional duties was mentioned by a few flyers. Although they knew they were not technically required to do some of these additional tasks, they knew the workload and problems of daily operations were just a few steps down the hall or a few days away after their mission. At home, some spoke of a subliminal pull to do more for their spouse and children. The reasons for this was not clear however, in general the spouses indicated that their young children were oblivious to the fact that they were going off to war and overall, the wives support was apparent[52]. The Whiteman AFB flight surgeon noted how the lack of combat transition time caused by the home base operation may have a stress of its own associated with it. The ability to sleep next to your wife and then wake up and drop 32,000-pounds of bombs on an enemy is not normal behavior and probably has some adverse affects associated with it[53]. Fortunately, the Air Force recognized that there were going to be hazards and went to great effort to prepare for the challenges.

Air Force Preparation of Aircrew

The aircrew had three positive aspects on their side influencing their level of physiological preparation for Operation Allied Force. From a physiological standpoint,

the leadership, training, and education all contributed to the mission's success.

The wing leadership at Whiteman AFB did an excellent job shifting the focus from a training environment to a combat operation without having the capability to physically change environmental conditions. The airmen's roles were clear and they knew their mission. This was accomplished without turning the base into a war zone avoiding unnecessary panic or confusion. The squadron leadership put together a feasible flight schedule that allowed expansion while permitting local training to continue if necessary, a key ingredient for long-term operations. The leadership kept the schedule close hold and yet it was set far enough ahead to allow the pilots to adapt their work-sleep cycle and to adequately prepare for the mission they were going to accomplish[54]. The supervision went as far as reserving billeting quarters for the aircrew if they did not think they could get adequate rest at home. After the flight, the pilots were allotted two days to recuperate. In theory, they could have been put back into the cycle immediately after the second day of rest. This option was not required due to the limited sortie production but it was available if needed[55].

The aircrews were well trained through a program that was both thorough and extensive. The three-day preparation

and training cycle used for Operation Allied Force proved its value. The pilots indicated it prepared them well for the flight. Additionally, all B-2 pilots were previously qualified in other aircraft and successfully completed a thirty simulator and six to eight flight training profile along with extensive hours of instruction. The newest B-2 pilots had additional flights prior to combat employment. Furthermore, they were only teamed up with the most experienced of aircrews. The five to seven month long upgrade program offers plenty of time for individual study and adjustment to B-2's unique systems. The specific portion of training that best prepared the pilots for the missions into Kosovo were the long-duration Weapons Systems Trainer (WST). These twenty-four hour long simulators gave the pilots a good idea of the monotony, stamina, and endurance necessary in the execution of global attack. During the simulator, the aircrews were able to replicate nearly all the actual in-flight procedures except the exact bathroom and the sleeping conditions. In every case, the interviewees felt the training prepared them for the magnitude of the flight they were going to accomplish[56].

The physiological education the aircrews received was very similar to the standard training all airmen receive during their formal Air Force flight courses. Refresher classes were conducted at the local level on various health-

related topics with emphasis on diet, physical fitness, and sleep. There was additional physiological training given to some of the initial cadre but as the duration of the conflict expanded, the training was not given to the additional aircrews, possibly due to an oversight. In general, the flight surgeons were not directly involved in the process that scheduled and maximized the pilot's performance but their educational influence was apparent in the organization[57].

The Adaptation to the Physiological Inhibitors

The airmen of Whiteman AFB faced some interesting challenges during Operation Allied Force. Their ability to safely execute each mission and fly the two billion dollar weapon platform unscathed was an impressive accomplishment. The number one adaptation helping ensure aircrew performance, meaning safely getting to and from the target while putting bombs on the target, was the realistic simulator training. The B-2 simulators provided a sterile yet authentic opportunity for training the required combat skills. By design, the B-2 gets into and out of a target area undetected allowing the pilots to focus on weapons delivery vice survival via threat reactions. The platform worked as advertised, as target area deviations did not significantly degrade aircrew performance. Besides training weapons delivery switchology, the long-duration simulators

provide realistic expectations and represent most of the challenges encountered in the executing global attack. The items that the simulator did not accurately emulate, the sleep conditions and restroom conditions were identified early and adequately adjusted to. The B-2's restroom facilities exceeded that of the simulator thus making the adaptation relatively easy. The sleeping conditions, potentially an oversight in the original design, was cured by a visit to a local store[58]. The open area behind the crew seats, which is large enough to lay down on, proved to be a poor location for sleep. The floor vibrations, combined with head-level cold air vents provide marginal conditions for rest. The Wal-Mart tri-folding lounge chair proved to be a compact and comfortable addition. It dampened the vibrations and elevated the snoozing aircrew's heads above the drafts providing a suitable environment for rest and relaxation during the mammoth voyage. Besides adapting to the conditions for sleep, the B-2 pilots had to significantly alter their approach to crew rest.

All Air Force pilots are ingrained to respect the concept of getting adequate amounts of rest prior to flight. The laws governing crew rest are written in blood of aviators. The opportunity for twelve uninterrupted hours of rest before flight is current guidance. The B-2 aircrew applied this paradigm in their initial approach to improve

aircrew performance. They carefully adjusted the duty days to maximize the twelve-hour window prior to receiving the recall for a mission. This approach proved to be one of the major lessons learned during the first ten days of the operation. By showing up fully rested, the crew found themselves prepared for a typical day of fourteen to eighteen hours of non-sleep time. This was several hours less than the number of hours from aircrew wake up to target area employment. Studies show that just seventeen hours of continuous wakefulness degrades aspects of performance to the same extent as a blood alcohol concentration (BAC) of 0.05%--the prescribed level of alcohol intoxication in many countries[59]. Instead of optimizing the aircrew's performance, the crew rest plan was setting the pilots up for reduced performance at the critical time it was needed. The leadership quickly realized this and made two key adjustments. First, they eliminated the attempt to alter the aircrew work-sleep schedules based on the start of the crew duty day. They adjusted the plan for the time-over-target (TOT) that was about twenty hours after wake up. To ensure maximum performance during the TOT, the pilot flying the target area portion of the flight needed to get his sleep shortly after takeoff or about seven hours into the crew duty day. In order to accomplish this the pilot was better off if he did not come to work fully rested[60]. This

thought went against everything the aircrews had ever been trained for. The change to pre-flight sleep was the first challenge. Adjusting in-flight sleep was next.

From interviews it was apparent the time available for sleep, usually the time other than used for AARs, was maximized by the resting pilots. This was difficult, as the pilots did not always find themselves tired at the times they were supposed to rest. With the duration of the mission and its demands came a schedule that took discipline to adjust to. This discipline was most important on the first mission where the pilot's adrenaline made them less tired until some point in the flight where they "hit the physical wall" and were unable to stay awake. Several pilots indicated that six hours was the maximum they could fly without relief. This time decreased on the return leg home where many pilots were too exhausted to complete the AAR without switching controls with their crewmate[61]. It is reasonable to conclude that the useful time at the controls decreases with an increased workload brought about by weather or communications problems. To make things worse, the stiff design of the seats that are straight backed and relatively hard added to the problem. A reclined seat available in other modern aircraft, was not selected in the final design. The hard seat was successfully modified with a blow up air cushion that added the necessary comfort[62].

IV. Assessment of Preparation and Adaptation

If a peerless force exists, the United States Air Force is a top candidate. The Air Force provides its pilots with the best training and aircraft in the world and Operation Allied Force reinforced this revelation. Additionally, the leadership created a climate that enabled mission success[63]. The environment contributed to the fact that there were no reported cases of stress related incidents.

Outside of the three-day cycle, it was life as normal for most flyers. Besides providing the pilots with the systems and training to succeed, success was also related to mental and physical preparation and to some extent, aircrew ability to compartmentalize their jobs from their family lives[64]. Not all of the human physiological performance matters pertaining to Operation Allied Force were stellar. According to Major General Short, "The Air Force did not forecast all the problems combat operations from home base presented. We were lucky. There needs to be further study on the adverse impacts of home basing as they were certainly there"[65]. However, the successes tower over weak areas that did surface. The next paragraphs substantiate this position by analyzing facts pertinent to the secondary research questions.

Are Air Force systems and training postured to reduce adverse human physiological affects? The B-2 and the

support aircraft necessary to fulfill the global attack mission performed above all expectations. The B-2's modern systems allowed aircrews to focus on combat employment and not on distracting aircraft systems problems. According to Captain Jim Dawkins, a B-2 student in training, "The B-2's stealth and ability to slip in and out of the combat zone make its mission relatively easy to reproduce in a simulator. The simulator accurately replicates the difficult tasks encountered, preparing the aircrews in ways that were not previously possible"[66]. The technological advances incorporated in the B-2 significantly reduce stress and cumulative fatigue associated with older systems that are not as advanced. This also applied to the sortie production side. The maintainers prepared and sustained the expensive and complex airframes to new levels of operational readiness. The mission ready aircraft rates were nearly 100%[67]. This gives aircrews increased confidence in their weapon system.

On a negative note, interviewees gave the impression that less attention was given to the environmental factors concerning families, their security, and the affects of flying combat missions from home base. An informal pilot's wives support network was in place, however the network's effectiveness varied per individual and there was no consistency in its implementation[68]. On issues concerning

the sleep management and deprivation, the results also varied.

In reviewing history, the researcher did not find any longer examples of crew duty periods for sustained aerial combat operations[69]. The thirty-hour missions were successful, however the added risks of the marathon flight combined with the extra hours on the airframe were certainly risky. The days were further stretched by the implementation of five hours of pre-flight preparation. The cumulative fatigue is a serious threat to aviation safety and efficiency. Research has proven that insufficient sleep is not only costly, but dangerous[70]. The attempt to optimize sleep schedules was a problem. Experience from the first missions provided better ways to adjust sleep patterns, ultimately improving performance in the target area. The use of "power naps", was used to minimize the stress induced during the long operation[71]. Conquering initial miscalculations in rest management was a positive event. Surprisingly, the flight surgeon was not integrated into the crew rest and duty day decisions and was not actively involved during the seventy-eight days of air strikes[72]. Overall, the researcher's impression was that adjustments to the sleep schedules were made in a reasonable manner indicating flexibility.

Did the environment foster the agility and the initiative necessary to counter the many unknown human physiological inhibitors? The handpicked and highly experienced pilot cadre was key to mission success. The high visibility B-2 program maintains a unique luxury in that it only interviews and hires proven pilots. This above average core of pilots' individual initiative and desire to make things better were critical. Aircrew expertise included a wide range of background knowledge to apply to the new high-stress situations they encountered. The myriad of wise aircrew decisions mitigated potentially devastating effects of compounding flight administration problems, weather, AARs, and sleep deprivation. Their mental maturity and agility not only prevented problems, but it also created new capabilities. The result of target information delays to global attack missions created one such capability. The pilots and mission planners did everything they could to prepare for the target arrays they might receive. The initiative of the B-2 ATO liaison to push accurate information to the planners for parallel planning was critical. Ultimately, pilot experience allowed flex targeting to flourish. The ability of the B-2 pilots to flex to new targets, when given updated information was a major event that was previously untested. "Flex targeting",

is a growth area for air operations and the B-2's success provides fuel to advance this capability[73].

The capacity to overcome the sleep challenges of deprivation and jetlag were equally impressive. The ability to get quality sleep in-flight, an oversight in the B-2 design process, was overcome making the lack of approved sleeping quarters a non-issue. The Wal-Mart lounge chair probably saved countless dollars in the B-2 acquisition costs[74]. The requirement and discipline to develop in-flight sleep schedules was a key adaptation that boosted aircrew performance. Most importantly, the ability to practice these unique requirements and disciplines in a realistic WST environment was essential. The imperative to have one aircrew at peak performance at any one time, in essence making the B-2 a one pilot airframe except during critical stages of flight, was an initiative that significantly reduced potential stresses from these physiological areas. Ensuring the pilot designated for weapon delivery was fully alert for his time in the target area took a radical approach to maximizing sleep and rest in flight.

V. **Recommendations for the Future Analysis**

The B-2 community has noted and internalized many of the points and lessons highlighted in this monograph. They have refined the in-flight sleep cycles and are actively

addressing the systems oversights for sleeping conditions and communications. The rest of the Air Force may not have had the time or resources to study these areas and the applicable lessons that transpired. The next section of the monograph addresses these lessons.

Having the capability to perform a mission does not mean that it is the best means or in some cases, even a feasible means to employ. The uncharted ground and risks associated with thirty-hour missions were vast. For the B-2 to make it through the seventy-eight day war without major incident is remarkable. This milestone should not be used as a mark to beat, but as an outer limit to stay within. The marathon sorties pushed the aircrew's physiological endurance. The principle means to reduce fatigue was to fly in shifts. Most pilots agreed that eight-hours as the primary pilot was too long. Airline pilots duty day limits are similar but they seldom spend more that six straight hours at the controls. They break up their day with layovers or take turns flying the aircraft[75]. The Air Force often pushes this limit as it is well within the twelve-hour crew duty day (which was not applied to the missions over FRY).

For fighter aircraft, the expectation for aircrews to operate in high demand environments, for periods longer than six hours, is asking for errors[76]. The inability to stand

up and freely move around logically reduces the productive time for maximum aircrew performance. If additional demands of night, weather, extended time over targets, or multiple AARs are required, the total times should be reduced further. For the larger multi-crewed airframes, a fifteen-hour mission duration allows two pilots to stay within their maximum window of optimum performance. A fifteen-hour mission still allows a one-way journey of 3000 miles to a target area. Using this approach two forward operating bases provide global coverage. Limiting the mission duration directly improves the next problem area of ATO lag.

The ATO was not responsive enough for missions that take off halfway around the world. The normal seventy-two hour and forty-eight hour planning windows are not in contention. It was the last twenty-four hours of the cycle left little time for critical mission planning. The current B-2 mission planning systems require at least four hours for mission planning. Additionally, five hours was added from show time to step time for briefings and pre-flight preparation. This means the ATO information was needed nine hours prior to take off. Assuming fifteen hours from take off to target, one can see the need for firm ATO information twenty-four hours from time-over-target (TOT). Often the ATO is still being refined twelve hours from execution and

changes occasionally come out in during the last twelve hours.

Other global attack aircrews have reduced the mission planning cycles and brief times to increase reactiveness. The F-16CJ community consistently demonstrates the ability to report for duty two hours prior to take off when scheduled for missions that last up to seven hours[77]. This ability requires additional preplanning, formed flights (or aircrew), pre-briefs of administrative issues, and the ability to provide in-flight updates. Implementing similar procedures for the B-2s could shave four to six hours off of the twenty-four hour requirement. If the take-off to target time is reduced to seven hours (fifteen hour missions), a reasonable chance for planning and briefing is made available. Still other refinements in the ATO process and the ability to make in-flight adjustments are necessary. The primary reasons the B-2s were able to plan within the ATO cycle was the role that the B-2 liaison played. A liaison pilot called as soon as he had some verbal confirmation on timing and target information so that the mission planners back at Whiteman could start planning. This informal mission planning system worked but it was not due to design.

Getting to and from the target area occupied the majority of the pilot's time and often much of his energy.

The coordination with Federal Aviation Administration (FAA) within the continental United States and with foreign control agencies often caused as much stress as the target area operations. The current requirement to fly a civilian airliner profile and file a civilian flight plan during combat operations needs reconsideration. A flight plan filed to Italy gave ample warning to individuals intelligent enough to gain access to the unclassified FAA system. Once airborne, the requisite for open radio communications and information passing to include aircraft type and altitude, on common unsecured frequencies, defeated some of the surprise the B-2 requires for it's ultimate success. These procedures, a necessary safety procedure for peacetime, require review for the combat execution of global attack.

After the administrative hurdles of air traffic control during combat were overcome, AARs added one more stress. The current AAR routes across the Atlantic Ocean are capped at 28,000 feet. In part, the B-2 is prohibited from flying higher because of a lack of FAA approved on-board collision avoidance systems. The requirement to stay within a corridor between 21,000 and 28,000 feet for the entire ocean crossing induced pilot stress, increased airframe risks, and wasted fuel. The B-2 operates best in the regime above 30,000 feet. The increased altitude reduces fuel flow and provides vertical coverage above most clouds and

thunderstorms[78]. The necessity to remain in this lower block altitude increased the chances of flying through clouds. The clouds may be associated with thunderstorms that often degrade communications, prohibit visual flight conditions, and increase turbulence. The thunderstorms often contain hail, ice, or static electricity that can adversely affect the electric systems of any airframe. The unnecessary exposure to weather is an unwise act for aviators. In fact, a substantial number of aviation accidents, weather is a primary cause contributing to the incident[79].

Fatigue is another major factor in transportation accidents. According to Jim Hall, a director at the Department of Transportation, operations at night and at the end of a normal duty day are the most susceptible to fatigue related accidents[80]. For global attack and air combat in general, the United States Air Force trend is towards increased night operations as it offers improved survivability for most weapons systems. The ability to minimize the pilot's work schedule and optimizing and synchronizing their sleep schedules is a must to ensure maximum performance throughout flight. This might even mean staggering crew sleep schedules to ensure a steady mental capacity throughout flight.

Aircrews are sometimes allowed to use sleep medication or stimulants to improve awareness or assist in getting sleep. A current Air Force directive prevents the use of stimulants yet allows the use of sleeping pills in limited situations with the commander's approval. During Operation Allied Force no B-2 aircrews used any medication to increase aircrew performance. Several aircrews, who have used the "pills" in other airframes, said that they could see circumstances where the use of a stimulant might be necessary towards the end of the mission. Others mentioned difficulties adjusting to their new sleep schedules and said how sleeping pills may have improved their adjustments to the new work schedule[81]. In the B-2s case, the decision not to use in-flight medication was effective, however future use should be considered. For example, the pilot flying back across the ocean could take a stimulant to ensure he stays awake during the routine and monotonous period following the third refueling. Another option is to allow one pilot the opportunity to take medication in flight in selected situations. This would be appropriate if one pilot became ill after take-off requiring the other pilot to perform the majority of the mission.

The final issue of concern that surfaced during the investigation on global attack was the issue of security. Presumably, there was an analysis of the local environment

and not surprisingly, the assessment in Central Missouri is that the threat of retribution or terrorism was low. Because this was the case, the lessons concerning this issue are easy to overlook. Force protection of the service members and their families is an issue that needs attention prior to the execution of global attack. One family member spent some time considering how vulnerable their family was if Serbian sympathizers decided to take direct action in retrobution[82]. As a minimum, the family members and local community should be prepared in some form to heighten awareness of the risks and to strengthen the force protection effort.

VI. Conclusion

This monograph used the B-2 performance in Operation Allied Force as a basis to study the Air Force's preparation of aircrew for the global attack mission. The ultimate goal was to determine if the Air Force adequately prepares its airmen for the physiological challenges they face. To meet this goal, an analysis of the Air Force systems and training pertaining to global attack was necessary. Furthermore, an assessment of the environment and climate it created was a requirement. To counter the uncharted human physiological inhibitors, an environment that fosters agility and individual initiative was indispensable. The findings in all of the areas of concern were positive in nature

indicating an overall answer of yes--the Air Force is adequately preparing its airmen for the global attack mission.

The B-2's excellent performance in Operation Allied Force was enabled by leadership, aircrew education, training, and the B-2 system itself. This success does not mean that improvements are not warranted. To recognize this, not ignore the facts, and focus on the areas that adversely influence physiological performance are key to continued fruition for global attack. An additional intention of the research was to determine how airmen are overcoming the physiological challenges so their lessons can be exported to future scenarios. Numerous examples were given. In simplistic terms the keys were solving the crew management issues, minimized external factors degrading physiological performance, and adapting to the dynamic environment with intelligent solutions. These facts went a long way to make global attack a success but they can not be expected to solve all the problems.

In the future, more attention is necessary concerning aircrew physiological performance. Where the sky was once the limit, the limits on global attack are now bounded by the physiological abilities of the men who execute it. This realization is contrary to the stance presented by some senior Air Force officers. Before the next conflict the Air

Force must recognize that is was both good and lucky in Operation Allied Force.

ENDNOTES

[1] Hearing of B-2 Performance in Operation Allied Force in Kosovo to the Military Procurement Subcommittee. (Washington, D.C.: Government Printing Office, 30 June 1999), p.5.

[2] *Air Force Doctrine Document 1* (Maxwell AFB, Alabama: Headquarters Air Force Doctrine Center, 1997), 27-40.

[3] Ibid., 32.

[4] Ibid., 33.

[5] Instructor Pilots (B-2), interviews by author, 19-20 July 1999. Whiteman AFB, Missouri. Tape recording. School of Advanced Military Studies, Ft. Leavenworth, Kansas. This conclusion was the result of feedback from the eight separate instructor pilots that were interviewed. The instructor pilots are to be considered the experts in B-2 employment and their inputs will be weighted heavier than that of the less experience pilots when concerning technical matters. In order to conduct the interviews, one condition was to withhold the names of the instructor pilots due to security concerns for them and their families. The tape recordings are secured by the author and identities of the individuals will remain confidential and close hold.

[6] AFDD-1, 1.

[7] Bruce W. Menning, "An Operator/Planner's Introduction to Operational Art, 1999". Ft. Leavenworth, Kansas: School of Advanced Military Studies, 4.

[8] AFDD-1, 11-13. According the AFDD-1, "Fundamental are its core competencies that are at the heart of the Air Force's contribution to our nation's total military capability".

[9] Ibid. 8. The core competencies are integral to the Air Force's existence as they define what they can do for the nation and what the nation needs to provide to accomplish the missions the Air Force is called upon to complete. The competencies are made possible by effective integration of platforms, people, weapons, bases, logistics, and all supporting infrastructures. The Air Force prides itself in its unrivaled ability to exploit its speed and the global nature of its reach.

[10] Brian L. Davis, *Qaddafi, Terrorism, and the Origins of the U.S. Attack on Libya* (New York: Praeger, 1990), 133.

[11] Davis, 169.

[12] Ibid., 135.

[13] AFDD-1, 32.

[14] *Whiteman Spirit* (Whiteman AFB, Missouri), 16 July 1999, 3.

[15] *Kansas City Star*, 17 May 1999.

[16] *Whiteman Spirit,* 12.

[17] Air Force Times, 17 may 1999.

[18] Hearing, 2.

[19] Pilots (B-2), interviews by author, 19-20 July 1999. Whiteman AFB, Missouri. Tape recording. School of Advanced Military Studies, Ft. Leavenworth, Kansas. This information was predominately from interviews with inexperienced B-2 pilots. A total of nine non-instructor pilots were interviewed.

[20] Instructor interviews. Stealth employment does not require SEAD assets to employment but in accordance with current Air Force doctrine, the synergistic benefits of SEAD are necessary for risk assessment considerations.

[21] Ibid. Minor external repair were required all of which were within what is characterized as "normal wear and tear".

[22] Pilot interview.

[23] Ibid.

[24] Instructor interviews.

[25] Pilot interviews.

[26] Instructor interviews.

[27] This observation came from an informal consensus of the B-2 pilots combined with first-hand observations of the author as assigned in his role as an F-16 mission commander during combat operations.

[28] Instructor interviews.

[29] Webster's, 636.

[30] Carlos A. Comperatore, et al., "Leaders Guide to Crew Endurance", 1996. Aeromedical Research Laboratory, Fort Rucker, Alabama: U.S. Army 1996. Other sources considered to compile the list of physiological factors of fatique include the text-fiche of: J. French, et al., entitled "Crew Fatigue During Simulated Long Duration B-1B Bomber Mission", 1994. and that of D. F. Neri et al., entitled "Simulated Sustained Flight Operations and Performance Part 1: Effects of Fatigue",1992. Both can be found into Combined Army Research Library, Ft. Leavenworth, Kansas.

[31] Webster's 301.

[32] Comperatore, 8.

[33] Pilot interviews.

[33] Ibid.

[34] Ibid.

[35] Hearing, 6.

[36] Comperatore, 8.

[37] Pilot interviews. Note all of the B-2 pilots have at least 1000 flight hours and at least one tour in another combat aircraft.

[38] Pilot interviews.

[39] Comperatore, 6.

[40] This occurred with numerous pilots and did not seem related to B-2 experience.

[41] Comperatore, 10.

[42] Instructor pilots. The instructor cadre also tended to fill many of the squadron leadership positions thus they were in best position to identify problems and to immediately implement changes.

[43] Instructor interviews. Every pilot mentioned more than one incident that in their opinions contributed to stress.

[44] James, Dawkins, Interview by author, 19-20 July 1999. Whiteman Air Force Base, Missouri. Tape recording. School of Advanced Military Studies, Ft. Leavenworth, Kansas.

[45] Hearing, 4.

[46] This observation was made at the conclusion of all of the interviews based on the author's analysis of the interviewees. The author is a graduate of Air Force Electronic Combat School, Air Force Weapons Instructor Course, and served as a weapons officer for an F-16 CJ squadron with a primary mission of suppression of enemy air defenses.

[47] Instructor interviews

[48] Pilot interview.

[49] B-2 Family Members (names withheld for security purposes). Interview by author, 19-20 July 1999. Whiteman Air Force Base, Missouri. Tape recording. School of Advanced Military Studies, Ft.Leavenworth, Kansas

[50] Ibid. Less than 100 B-2 pilots existed at the time.

[51] Melvin, Deili, Interview by author, 19 July 1999. Whiteman Air Force Base, Missouri. Tape recording. School of Advanced Military Studies, Ft.Leavenworth, Kansas.

[52] Family interviews. It must be noted that the pilots only flew 1-3 missions each, so the long-term affects of such an operation were not measurable.

[53] Hooper, Lawerence. Interview by author, 19 July 1999. Whiteman AirForce Base, Missouri. Tape recording. School of Advanced Military Studies, Ft.Leavenworth, Kansas.

[54] Instructor interviews.

[55] Pilot interviews. The instructor cadre who set up the program were able to fly combat mission with many of their students. Besides the training that occurred during the 3-day cycle, the sleep patterns were adjusted to better conform to the mission. Although these adjustments required modification, it did show the leaderships attempted to address one of the major physiological factors influencing pilot performance.

[56] This observations was surprising but it was validated by the pilots, the squadron leadership, and the flight surgeon independently.

[57] Pilots interviews. An official Air Force solution to this problem was addressed prior to Operation Allied Force but was not fielded at the time of this research.

[58] John A. Caldwell Jr., "Sleepiness in the Cockpit." The Combat Edge, August 1999, 4.

[59] Pilot interviews.

[60] Ibid.

[61] Ibid. The cushion is commonly referred to as the "donut".

[62] Ibid. The majority of the pilots recognized the leaderships role in shaping the combat environment necessary for this mission to succeed.

[63] Hooper.

[64] Lt. General Michael Short, Lecture Notes, 6 September 1999, Ft. Leavenworth Kansas. School of Advanced Military Studies, Ft.Leavenworth, Kansas. General Short presented three presentations on this date to distinct audiences. The author was fortunate to attend all three presentations which included question and answer sessions.

[65] Dawkins

[66] Instructor interviews. Typical air Force mission rates range for the low 90% range down to the 70% range.

[67] Pilot interviews.

[68] Family interviews.

[69] Researcher inquired into numerous sources attempting to find information to the contrary.

[70] John A. Jr. Caldwell, "Predicting the Ability to Maintain Alertness During Sleep Deprivation: The Accuracy of Subjective Evaluations", 1997. Fort Rucker, Alabama: U.S.Army Aeromedical Research Laboratory, 7.

[71] Hearing, 4.

[72] Hooper.

[73] Short.

[74] Pilot interviews.

[75] Pearro, Thomas, Telephone interview. 1 Oct 1999. Lansing, Kansas. LtCol Perraro (ANG) is a Captain for United Airlines.

[76] This is the author's personal view based on 14 years of flight experience and 2500 flight hours in mostly single-single fighter aircraft.

[77] The demand for SEAD aircraft (F-16CJ, EA-6B et al.) requires them to fly whenever any aircraft are airborne over potentially hostile territory. This fact made the platforms modify their mission planning and briefing procedures to maximize efficency.

[78] Instructor interviews.

[79] Jim Hall, Transportation Safety, 1999. Interview presented on National Public Radio. School of Advanced Military Studies, Ft.Leavenworth, Kansas.

[80] Ibid.

[81] Hooper.

[82] Family members interviews.

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[1] testimony
[2] (AFDD-1 pg. 27-40)
[3] afdd-1 P. 32
[4] Ibid. p. 33.
[5] (Interviews)
[6] (AFDD-1 pg. 1
[7]
[8]
[10] (Davis pg. 133).
[11] Ibid. pg. 169).
[12] Ibid. pg. 135).
[13] (AFDD-1 pg. 32).
[14] (Whiteman Spirit pg. 3).
[15] (KC Star, 17 May 99).
[16] (Spirit, p. 12)
[17] (AF Times 17 May 99).
[18] (Testimony)
[19] (Interview)
[20] Interview
[21] (Testimony)
[22] Interview
[23] Interview
[24]
[25]
[26]
[27]
[29]
[40] Interview