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# **MASTER OF MILITARY STUDIES**

**V/STOL SHIPBOARD RECOVERY: “IT’S NOT JUST ANOTHER CARRIER  
LANDING”**

SUBMITTED IN PARTIAL FULFILLMENT  
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## *EXECUTIVE SUMMARY*

**Title:** V/STOL SHIPBOARD RECOVERY: “IT’S NOT JUST ANOTHER CARRIER LANDING”

**Author:** Major A. G. Shorter, United States Marine Corps

**Thesis:** The USMC Harrier force trains and sometimes operates at less than its full potential, in regards to the shipboard environment, this can be counteracted by introducing changes to the training and currency requirements that generate these limitations.

**Discussion:** The United States Marine Corps operates the only vertical/short take-off and landing (V/STOL) jet aircraft in the United States, the AV-8B Harrier. This aircraft provides the USMC with a unique basing flexibility not found in conventional jet aircraft. That basing flexibility allows the Harrier to operate from all classes of aircraft carriers and most classes of amphibious shipping without the need to rely on any of the sophisticated launch or recovery systems normally associated with conventional aircraft carrier operations. The Harrier is the only aircraft that can accomplish shipboard operations (take-offs and landings) using routine procedures that are the same as those for shorebased launch and recovery operations. The USMC Harrier force trains and operates at less than its full potential because of the tendency to unnecessarily apply conventional aircraft carrier training and operating procedures to the Harrier. The current V/STOL shipboard training and currency requirements do not maximize the use of limited manpower and operational flying time with respect to the highly technical, mission oriented, tactical core skills training. Once the evolution of the Harrier is explored and the shipboard operations fully examined, it becomes evident that, however difficult it may be, a change is needed in the Harrier’s present shipboard operations and training.

**Conclusion:** There are historical elements that contribute to this situation as well as adherence to perceptions that either were or are now invalid for the current conditions. However logical and sensible these measures may have been or seemed to be up to this point, the current standards can and should be changed to more closely reflect the modern capabilities and requirements of today’s V/STOL force. The Harrier force of today must learn to embrace the legacy of its efficiency, when conducting shipboard operations, and to discard the conventional aircraft’s burden that currently hampers training and operations for the same.

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**CHAPTER 1**  
**INTRODUCTION**

The true measure of the Vertical Short Takeoff or Landing (V/STOL) jet aircraft's value to the United States Marine Corps is its ability – current and future – to carry out the assigned mission regardless of the circumstance. The current V/STOL jet aircraft utilized by the USMC is the AV-8B and its mission, in its simplest form, is to provide responsive, close air support, by combining the speed and firepower of a jet attack aircraft with a unique basing flexibility.<sup>1</sup> The utilization of this unique basing flexibility will be the focus of this paper; more specifically, the aircraft's adaptability as it relates to shipboard operations will be analyzed.

While V/STOL operations were designed from the very beginning to be flexible from a basing perspective, they also proved to be a very efficient and effective means of launching and recovering jet aircraft. This is especially evident in regards to operations aboard ship, specifically in the amphibious environment, as there are many additional L-class (landing) ships from which V/STOL aircraft can operate that conventional fixed-wing aircraft cannot.<sup>2</sup> While the shorebased flexibility of V/STOL operations may be readily apparent (e.g., operations from damaged runways or road surfaces), its adaptability at sea may be less obvious. This point stems from the fact that current V/STOL shipboard training and currency requirements are derived from, and reflect too closely, the training and currency requirements for conventional aircraft operations

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<sup>1</sup> NWP 3-22.5-AV8B Volume I, *AV-8 Tactical Manual* (Washington, DC: Department of the Navy, April 1996), 1-1.

aboard aircraft carriers. These extraneous and unnecessary efforts to mirror the conventional take-off or landing (CTOL) community efforts waste time and resources that could be used toward broadening tactical core skills training and maintenance. In order to keep within the intent of this paper, primary consideration will be given to the shipboard environment and will only reference land-based operations as required.

The focus of this paper is the USMC's approach to pilot training and maintenance of currency for V/STOL aircraft afloat, which is aimed at finding a safe, yet more streamlined and efficient method of preparing and embarking AV-8Bs onboard Landing Helicopter Assault ships (LHAs) and Landing Helicopter Dock ships (LHDs). The USMC Harrier force trains and sometimes operates at less than its full potential, in regards to the shipboard environment, this can be counteracted by introducing changes to the training and currency requirements that generate these limitations. I will describe and analyze V/STOL shipboard training and its impact on operational effectiveness, by illustrating how training and currency requirements were established and approved, and exploring if they can be improved. Based on ten years of experience as a V/STOL Landing Signal Officer (LSO), with over 1400 hours in the AV-8B that include tours in all three Marine Air Wings and the Royal Navy, I believe that change is necessary to ensure future operational success. The paper is organized into three main concepts to be analyzed: the reason for change, the resistance to change, and the ability to change.

The reason for change has already been introduced – the ability to harvest the inherent adaptability and efficiency of V/STOL shipboard operations in order to free up valuable training time for other, more complex mission tasks. Those complexities stem

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<sup>2</sup> LtCol Louis K. Keck, USMC, *V/STOL in the Marine Corps*, Professional Study, Report Number 5493 (Maxwell Air Force Base, AL: Air War College, Air University, April 1974), 1.

from the management of advanced weapons systems such as radars and targeting pods and their role in increasing the aircraft's use throughout the mission spectrum, which themselves have become increasingly complex due to the sophistication of modern threats as well as the level of effects required of each mission. The resistance to change involves V/STOL's legacy to the conventional forerunners of aviation at sea, and also the perceptions that were incorrectly formed during various turbulent periods of the Harrier's expansion within the Marine Corps. The legacy also applies to the fact that some of today's V/STOL shipboard currency requirements are maintained as an incentive to generate flight time, for pilots, which might not otherwise be available during extended at-sea periods. In fact, the community has established shipboard currency requirements that were created to address general flight time currency while embarked instead of establishing realistic currency limits for executing a shipboard landing. I will conclude by exploring the ability to change V/STOL shipboard training and operations. I maintain that the USMC indeed has the ability to make what I see as necessary changes. By exploring the roots of V/STOL adaptability to shipboard operations, and by incorporating the best practices, whose risks have been mitigated by improvements of the aircraft over two decades of community and industry knowledge.

It is important to understand that these three concepts set the stage for the argument, an argument that will be preceded by a brief historical account of the Harrier's inception and its role in transforming fixed-wing jet operations aboard ship. This historical review includes observations of Great Britain's Royal Navy, which has handled the Harrier's shipboard training and operations differently than the U.S. Through an exchange tour with the Royal Navy (1998-2001), I had the opportunity to experience the

Royal Navy's use of V/STOL aircraft at sea, and I intend to reference these experiences in order to provide perspective and to give real world examples of how less restrictive requirements than those currently observed in the USMC can still provide safe and effective results while operating Harriers afloat.

## **CHAPTER 2**

### **THE HARRIER'S ORIGINS**

As early as 1951, the U.S. Navy Department issued a requirement for a vertical takeoff or landing (VTOL) fleet fighter. This new American fighter was envisioned as a “tail-sitter” using a powerful turbo propeller for propulsion; that is it would take off vertically and push over into horizontal flight and then, upon recovery, would be maneuvered back into the “tail-sitting” position to land.<sup>3</sup> While this concept did actually fly in 1954, as the XFY-1, the U.S. Navy subsequently decided to abandon its quest for vertical takeoff combat aircraft by 1956. Apparently, the Navy’s views on the requirement for VTOL aircraft were influenced by two factors. First, there was a powerful senior element within the U.S. Navy dedicated to the conventional aircraft carrier, which would be jeopardized by this aircraft.<sup>4</sup> Second, and most appropriate to this discussion, the proposed method of “tail-sitting” would have been very difficult to implement operationally. Therefore, at that juncture, the U.S. Navy firmly placed its future in the large-deck aircraft carrier, which would continue to require angled decks, catapults, and arresting gear in order to support modern, high performance aircraft. These aircraft also require additional, specialized equipment to operate from ships, such as arresting hooks, launch bars, and heavy-duty landing gear, the last of which is needed to absorb the massive kinetic energy imposed on touchdown. The touchdown is achieved in a specific area on an aircraft carrier, which requires a highly trained pilot to fly through

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<sup>3</sup> Francis K. Mason, *Harrier* (Annapolis, MD: Naval Institute Press, 1981), 7-8.

<sup>4</sup> Mason, 8.

a “gate,” which is roughly 30 feet wide and 10 feet high. As John Fozard, Chief Designer for the Harrier (1965-78), stated, this feat represents a “triumph of technology over necessity”, which was his way of saying that we had created these complex ships, special purpose aircraft, and procedures as the only way to enable high performance jet operations at sea.<sup>5</sup>

While the U.S. Navy was experimenting with an aircraft to provide basing flexibility, other nations also entertained the idea of a VTOL aircraft, and it was the United Kingdom which was the first to fully commit to designing and producing a lightweight VTOL fighter. First hovered in 1960, the P1127 was a single-engine jet fighter that utilized four rotating jet exhaust nozzles to vector its thrust for vertical flight.<sup>6</sup> This unique feature allowed the aircraft to take off and land in the same attitude as the conventional jet, but did so vertically (or slowly when ashore). As one may imagine, this was not as difficult or as disorienting a transition for the pilots as the tail sitter would have been. While the original VTOL concept in the U.K. was directed at producing a fighter that did not require a large land airfield, it did not take long for ship compatibility trials to commence. As early as February 1963, the chief test pilot for the P1127, Bill Bedford, made the first successful launches and recoveries on *HMS Ark Royal*.<sup>7</sup> Fozard, underlining the unexpected success and ease of the first launch, notes:

These first-ever jet V/STOL trials at sea made use of the same principles and virtually the same techniques as are employed today. Launch by vertical take-off or short take-off and recovery by vertical landing...there were no cliff-edge effects, the deck did not buckle due to the hot jets, vertical landing whilst formatting on a moving platform was indeed not a problem and turbulence caused no concern. Most

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<sup>5</sup> John W. Fozard, *The Jet V/STOL Harrier – an evolutionary revolution in tactical air power* (Surry, U.K.: British Aerospace, 1978), 82.

<sup>6</sup> Myles, 56.

<sup>7</sup> Fozard, 83.

importantly, the techniques developed for P1127 land operation proved equally applicable at sea with all the implications this held in respect of future pilot training. Bill Bedford had never before flown a fixed-wing jet aircraft from a deck.<sup>8</sup>

By 1966, the U.S. was testing the follow-on aircraft to the P1127, the Kestrel, as part of the Tripartite Agreement.<sup>9</sup> There had only been minor modifications made to the original P1127: it was nine inches longer and had a larger tailplane to increase longitudinal stability.<sup>10</sup> While the U.S. was busy doing its testing as a semi-technical development exercise, the U.K. saw it as an operational trial. As a consequence of those differing objectives, all of the Americans were test pilots, while those from the Royal Air Force (RAF) were line squadron pilots.<sup>11</sup> As intended, the RAF pressed on with its operational trials to achieve a straightforward assessment of the Kestrel as a close support aircraft. This close support aircraft, however, would be operated from a number of semi-prepared sites -- portable 70 square foot operating pads -- as well as from portable steel planking laid in confined areas.<sup>12</sup> The only prior experience these line pilots would have with any of these operations would be a simple demonstration in one of the aircraft by the manufacturer's test pilots, who would instruct on "advanced operating techniques."<sup>13</sup> Important to note is that the initial design characteristics of the aircraft were intended to be simple – simple to build, simple to maintain, and simple to operate. The original aircraft designed with these characteristics in mind did serve its purpose as a demonstrator; however, it was underpowered and less stable than desired. Even so, after

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<sup>8</sup> Fozard, 83.

<sup>9</sup> On January 16, 1963, the Tripartite Agreement – between Great Britain, the United States, and Germany – was signed in Paris on the basis of the cost of three aircraft and one-third of the development costs being borne by each nation.

<sup>10</sup> Mason, 53.

<sup>11</sup> Mason, 53.

<sup>12</sup> Mason, 57.

<sup>13</sup> Mason, 57.

nine months of intensive flying, the testing had proved that the Kestrel could operate from remote, austere sites with little training and that it did not require an overly-skilled pilot to handle a vectored-thrust aircraft.<sup>14</sup> The U.S. was quick to seize the initiative in testing the aircraft at sea, including shipboard suitability trials aboard the aircraft carrier *USS Independence* and the assault ship *USS Raleigh* during May of 1966.<sup>15</sup>

Shortly after the RAF had made the decision to acquire the Harrier (the follow-on production version of the Kestrel), the USMC made a similar decision and, despite conservative misgivings by the U.S. Navy, the purchase plans for the first 12 Harriers were approved for fiscal year 1970.<sup>16</sup> The USMC was quick to capitalize on the earlier shipboard trials completed in 1966 by the Kestrel aircraft, and started operations as early as February 1971 with ship compatibility trials.<sup>17</sup> These trials would not include large aircraft carriers but instead focused on the amphibious assault ships, the landing platform helicopter (LPH), and landing platform dock (LPD). Upon completion of these trials aboard the *USS Guadalcanal* (LPH), and the *USS Coronado* (LPD), the U.S. Navy officially approved Harrier operations from L-class ships. This was significant in that it was the world's first jet aircraft to be cleared for these operations.<sup>18</sup>

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<sup>14</sup> Myles, 105.

<sup>15</sup> Mason, 107.

<sup>16</sup> Mason, 109.

<sup>17</sup> Mason, 113.

## **CHAPTER 3**

### **SETTING THE STAGE FOR V/STOL AT SEA**

Specifically, a V/STOL aircraft's effectiveness while afloat is a function of its efficiencies generated by the following factors inherent to V/STOL operations at sea:

1. The ability to maintain a continuous ready deck
2. More unconstrained use of available aircraft flight time
3. Better utilization of available deck space
4. The ship's maneuvers are more independent of wind on deck (WOD)
5. Faster launch and recovery rates
6. Faster aircraft turnarounds due to reduced respot requirements
7. Greater residual capacity to continue flight operations even if the ship receives battle damage
8. Greater freedom to adjust air plans during execution in responding to contingencies<sup>19</sup>

These factors, when exploited correctly, produce greater strike effectiveness for V/STOL aircraft at shorter ranges, and remain on par with conventional take-off or landing (CTOL) aircraft at longer ranges.<sup>20</sup> These results assume, of course, that the forces conducting V/STOL operations at sea adhere to the principles and practices that would support the factors listed above in order to achieve results efficiently. Unfortunately, the USMC's Harrier force does not appreciate the value of many of the factors listed above and with a general lack of awareness the force operates at less than

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<sup>18</sup> Mason, 113.

<sup>19</sup> American Institute of Aeronautics and Astronautics, *An Assessment of Sea Based Air*, Master Study, AIAA-80-1820, August 1980, 9-10.

<sup>20</sup> AIAA-80-1820, 10.

the full potential when performing operational missions. In addition, the Harrier force does not provide the required tactical training to achieve a minimum level of effectiveness from its forces while embarked. It can be argued that the USMC does not take advantage of all of the eight factors, and the failure to do so is, or can be, due to limiting factors imposed by certain MEU-specific mission issues. This mission-related non-compliance, such as the first factor listed – the ability to maintain a continuous ready deck - is often related to the amphibious ships' multi-mission nature, where the V/STOL assets cannot be exploited because of the competing priorities for deck space. These physical restrictions, however, are usually limitations, which can be overcome through simple coordination, in order to minimize their effects on training and operational missions. On the training side, however, many of the issues, such as the need for a certain WOD direction for recovery, are rooted in legacy requirements taken from CTOL operations when embarked at sea, which limits the efficient use of the cross axial landing.<sup>21</sup> These training issues, whether related to initial training or to the requirement for currency while embarked, are in many cases very restricting and undermine many of the factors that give the V/STOL aircraft its flexibility and efficiency while embarked. It is a well-known Harrier pilot's aphorism that it is "far better to stop and land, than land and try to stop."<sup>22</sup> Why, then, does the time-consuming training regimen for stopping and landing so closely resemble that for landing and stopping? The truth lies somewhere in the move from CTOL ship operations to V/STOL ship operations, depending on one's background. If a V/STOL force of U.S. naval aviators is trained by a large cadre of

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<sup>21</sup> A cross axial landing is a landing in which the longitudinal axis of the aircraft is not aligned with the longitudinal axis of the ship, but instead is aligned into the WOD. The difference between that and standard axial landings are being generated from the ship not steaming directly into the local atmospheric wind.

highly experienced Landing Signal Officers (LSOs) and is only a small fraction of a larger sea-going CTOL force, it will historically be trained along CTOL lines, thereby not taking full advantage of V/STOL's adaptability to operations afloat. However, if a force is part of a small professional Navy that has given up CTOL ship operations and relies solely on V/STOL aircraft, it is free to train in a way that optimizes the new technology of the aircraft. As a case in point, the Royal Navy fits the latter description and is able to employ its V/STOL forces while maximizing all of the capabilities of V/STOL shipboard operations. The Royal Navy achieves this higher level of effectiveness partially because of eased training and currency restrictions that rely on the Harrier's large approach "window," which is unlike that of CTOL aircraft, which, as previously mentioned, has very narrow approach limits.<sup>23</sup> That fact is explained in this passage from *Jump Jet*, which refers to the criticality of the "gate" used in place of "window" for conventional carrier pilots, as opposed to what is required for a Harrier pilot:

Deck landing accidents have long been related to approach speed. This is a fact of naval aviation life, which encouraged the development of arrestor gear, angled decks, and mirror landing sights and other complex deck aids. The precise point through which the naval pilot must aim on his final approach to the deck is known as the "gate." He must hold a precise speed of up to 130 knots, and keeping a precise heading, he must pass through this "gate"...Imagine what it is like when the deck is pitching and rolling at the same time. It is clearly not a job for the fainthearted or the unskilled, but the adrenalin that conventional fixed wing pilots expend on deck landing, the Harrier pilot can save for combat. In the decelerating transition from wingbourne to hovering flight, he does not even have to aim at the ship. Errors of speed can be corrected by adjusting the length of the transition to the hover. In the final hover, if the deck is partially blocked, the Harrier can "air-tax" to a clear part of the deck. Kinetic energy, the energy associated with motion, has always been the problem in

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<sup>22</sup> Bruce Myles, *Jump Jet; The Revolutionary V/STOL Fighter* (San Rafael, CA: Presidio Press, 1978), 28.

<sup>23</sup> Myles, 28.

recovering heavy aircraft at sea. The Harrier gets rid of that energy, before it lands, not after it has hit the deck.<sup>24</sup>

By identifying the training inefficiencies and by taking advantage of advances in technology, we can inject flexibility into the Harrier training requirements, so that the USMC could not only increase the Harrier's effectiveness in current operations but could also gain valuable training time now expended on redundant shipboard training. A less restrictive currency requirement would also allow more flexible deck planning during exercises and lower the risk of non-preparedness for contingency operations. With a restructured carrier qualification syllabus, additional sorties could be made available for gaining or maintaining the ever-expanding list of tactical skills. Perhaps most important would be a leadership awareness that V/STOL shipboard operations, when executed properly, are no more complex and are equally as manageable and very similar to routine land-based V/STOL operations.

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<sup>24</sup> Myles, 216-217.

**CHAPTER 4**  
**THE REASON FOR CHANGE**

In 1986, the USMC began continual shipboard deployment of its AV-8B Harriers as part of the Air Combat Element (ACE) within its smallest Marine Air Ground Taskforce (MAGTF), what was then named a Marine Amphibious Unit (MAU).<sup>25</sup> With the exception of engine problems in 2000, which affected a few MEUs, the AV-8B's have been embarking aboard LHA's and LHD's continually since 1986 as part of the MEU's ACE.<sup>26</sup> The ACE embarks with a helicopter marine medium-lift (HMM) squadron, reinforced with Hueys, Cobras, CH-53's and six AV-8B Harriers. The six jets, as well as the nine pilots and numerous maintenance and support personnel, are detached from the parent Harrier squadron for the duration of the deployment. While deployed, as part of this HMM, the Harriers are expected to perform the same missions as can be expected of a fixed-wing Marine attack (VMA) squadron, including attacking and destroying surface and air targets, escorting helicopters, and conducting such other air operations as may be directed. As noted in the USMC's AV-8B fact/file, specific tasks include:

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<sup>25</sup> LtCol Jay C. Lillie, "Seabasing the Harrier," *Marine Corps Gazette*, Vol. 71, no. 5 (May 1987), 78.

<sup>26</sup> The recent engine problems, which caused Harrier MEU Dets. to quit flying for extended periods have hopefully been an exception to the problems of gaining and maintaining currency, and are only referenced here for factual information.

1. Conduct close air support using conventional and specific weapons.
2. Conduct deep air support to include armed reconnaissance and air interdiction, using conventional and specific weapons.
3. Conduct offensive and defensive anti-air warfare. This includes combat air patrol, armed escort missions, and offensive missions against enemy ground-to-air defenses, all within the capabilities of the aircraft.
4. Be able to operate and deliver ordnance at night and to operate under-instrument flight conditions.
5. Be able to deploy for extended operations employing aerial refueling.
6. Be able to deploy and to operate from carriers and other suitable seagoing platforms, advance bases, expeditionary airfields, and remote tactical landing sites<sup>27</sup>

While close air support is the primary task, there are many other tactical tasks that require the same amount of proficiency to conduct safely and effectively, such as the “hands-on” requirement to frequently use all of the weapons systems and airborne sensors that the aircraft now possesses.

To prepare for all of these missions, a pilot must undergo a systematic training period to become combat ready in accordance with the current version of the AV-8B training and readiness (T&R) manual.<sup>28</sup> This training period may include initial qualifications of certain core skills, or it may only require re-currency to maintain a core skill competency. Whatever the case, there is a requisite number of sorties to be flown to

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<sup>27</sup> United States Marine Corps Fact File. “AV-8B.” Downloaded from the World Wide Web, <http://www.hqmc.usmc.mil/factfile/nsf>, 26 October 2001.

<sup>28</sup> The T&R manual is a Marine Corps Order that provides guidance to ensure each like squadron maintains a common base of training and depth of capabilities.

either achieve or maintain a tactical core skill competency. This number is significant in two ways. First, the number for an initial qualification in a core skill is much higher than it is to re-qualify for that skill. Second, once qualified or re-qualified in a core skill, a pilot must fly a certain number of sorties in that skill every three months in order to remain competent or qualified in that skill. This methodology generates a practical accounting method for objectively tracking and assessing the tactical ability of any one pilot, or any squadron collectively, to meet the stated mission tasks. From those six tasks, the AV-8B T&R manual has divided the core skills into twelve categories, as seen in the table below.

**Table 4.1**

	Air to Ground	Air to Air	Radar Air to Air	Low Alt. Tactics	Night Systems	N S LAT	Defensive Counter-Measures	PGM's	Aerial Refueling	Forward Based Operations	FCLP	CQ
Initial Sorties	12	6	2	5	9	4	1	1	2	2	*2	*2
Refresher Sorties	8	3	1	4	6	2	1	1	0	2	*2	*2
3-Month Currency	4	2	1	1	3	1	1	1		1	**2	**2

\* While these two sorties are supposed to cover both day and night operations and be of one hour's duration, in reality more sorties and flight time are required for each. For instance, while the day field carrier landing practice (FCLP) period may be completed in the same sortie, the night FCLP and carrier qualification (CQ) periods by definition require two sorties (Eight night takeoff and landings are required, but only four may be done in any 24 hour period).

\*\* T&R states that this must only be met yearly, but to do so you must refer to the V/STOL LSO NATOPS for the initial qualification.

Incredibly, out of these twelve categories, the three on the right (FBO, FCLP, CQ) are dedicated to only one of the six aforementioned tasks, a task focused only on launch and recovery. Admittedly, the initial qualification seems as if it is of a reasonable percentage as a portion of the other required initial sorties, but that ratio is only valid for

new pilots from the Fleet Replacement Squadron (FRS). However, when one considers the true time, effort, and flight-hour requirement for the initial qualification as is written in the *V/STOL LSO NATOPS*, it becomes a more daunting and sobering task.<sup>29</sup> The difference stems from the fact that the T&R manual only allots a single theoretical hour and one sortie for evolutions that typically require two sorties and several hours. Therefore, when “actual” training periods are developed and compared to the three-month currency requirement, almost 30% of the minimum sorties required are dedicated to V/STOL operations, if embarkation is imminent, or if more than one year has elapsed since a pilot’s last carrier qualification (CQ) period. There is another portion of the skills competency equation that is out of balance, and it concerns prior experience. A second-tour pilot is only responsible for roughly 60% of the sorties that a first-tour pilot must complete to achieve core competency in all areas in the tactical tasks. This is understandable, because the more experienced pilot should be able to gain competency - even of these highly perishable skills - much quicker than a newer pilot. However, in those basic skills associated with launching and recovering to austere sites or sea-based platforms, the second-tour pilot is given no credit for his experience and is required to fly the same number of CQ/FCLP sorties required of a new pilot. All of these sortie allocation ratios are severely out of proportion, not only with the implied mission tasks themselves, but also with the difficulty or individual pilot effort required to maintain a competency in those skills. It demands much more effort to maintain competency in close air support, deep air support, offensive and defensive anti-air warfare, and night systems operations, than to execute any form of launch or recovery operations, land- or

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<sup>29</sup>NAVAIR 00-80T-111, *V/STOL Landing Signal Officer Naval Air Training and Operating Standardization Manual* (Washington, DC: Department of the Navy, April 1996), 17-1.

sea-based. That is because the complexity of the modern battlefield, sophistication of current threats, and the technical aspect of the aircraft's weapons systems far outweigh the routine that a pilot faces in the landing pattern, whether ashore or afloat. That, coupled with the poor operational availability, caused by insufficient resources, recurring material problems, poor reliability, and inadequate manning and experience levels that are associated with the Harrier, leads to insufficient flying time and decreased training opportunities to begin with.<sup>30</sup>

As part of my experience with the Royal Navy, I was allowed to embark aboard *HMS Illustrious* for an operational deployment without any FCLP or CQ periods even though I was flying the more challenging and less stable Sea Harrier and I had not flown to a ship for at least three years. Even so, it was not difficult, and the 30-40 vertical landings that I had done to the simulated carrier deck in the previous six months had prepared me adequately for the experience. This user-friendly method allows the squadron to concentrate on training of tactical core skills and on increasing each of the pilot's individual tactical proficiencies, which ultimately leads to an increased combat effectiveness once deployed. The squadron does not waste valuable pre-deployment time working up the aircrew for something that they see as a core capability of the aircraft that is practiced weekly (if not daily) by executing routine, unmonitored, vertical landings to a simulated carrier deck on the airfield.

The T&R manual is a valuable document that is painstakingly updated to reflect the subtle and sometimes not-so-subtle changes within the Harrier community. Nevertheless it does not adequately address the imbalances of training time between

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tactical sorties and CQ, while it even dismisses the true amount of time and sorties required for FCLP or CQ. The misalignment of sortie percentages occurs because shipboard operations and currency are driven by a separate publication, mentioned earlier, the *V/STOL LSO NATOPS*. This publication is administered by a separate authority and is mainly concerned with the roles and responsibilities of the V/STOL LSO as they relate to safety for conducting shipboard operations, training, qualifications, and the maintenance of currency. It becomes evident that the guidelines for establishing a pilot's combat capability are subservient to, and in some cases diluted by, disproportionate demands of the shipboard training and currency requirements. The T&R manual evolves in order to support the mission tasks of the Harrier squadron while trying to capitalize on the numerous upgrades (technical and improved weapons systems) to the aircraft. Along with those upgrades comes greater mission scope within the assigned tactical tasks, and the requirement for more dedicated sorties to support them. Conversely, V/STOL operations are a primary skill taught extensively in the training squadron; they do not change, and they are practiced routinely at the end of each sortie. It is important to ask why, in regards to preparations for shipboard operations, the current V/STOL requirements account for a relatively large percentage of the training focus. Historical examples tend to support the adaptability of V/STOL operations at sea and use a "don't make it any harder than you have to" approach as the RAF practiced in 1970. The RAF was quick to exploit its new aircraft by embarking a pair of Harriers on *HMS Eagle*, with the intent to carry out sea trials so that a service release could be written for

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<sup>30</sup> Harrier Review Panel (HARP), "First Annual Report," Downloaded from the World Wide Web, <http://hqmc.usmc.mil/harp/nsf>, accessed 26 September 2001.

deck operations.<sup>31</sup> It wasted no time thereafter in taking their Harriers to sea aboard *HMS Ark Royal* and conducting mishap-free operations, without any of the squadron pilots ever having flown to or from a ship.<sup>32</sup>

While embarked, if a pilot has the opportunity to launch and recover aboard ship at least once every fourteen days, the currency requirements for either FCLP or CQ are fulfilled. Every sortie would be dedicated to tactical core skills, and the recovery back aboard ship would just be a matter of routine. Unfortunately, due to the nature of the MEU (SOC) and its multidimensional application - whether in training or in real-world situations - the Harriers do not necessarily experience regular or extended flying periods. This point is widely understood and was highlighted in the Harrier Review Panel's (HARP) first annual report as one of the panel's two concerns for shipboard operations.<sup>33</sup> Often, the Harrier detachment will disembark in order to alleviate the problems of extended non-flying, at-sea periods. Unfortunately, under the current currency system that does not help the deck landing currency limit, FCLP's will be required after twenty-nine days without a deck landing. This limit can easily be reached, for example, after 10 days of inactivity on the ship followed by twenty days based ashore. The detachment would then have to do some form of FCLP's in order to return to the ship.<sup>34</sup> The problems become evident once one attempts to balance shipboard qualification or currency with combat skills competency when embarked with the MEU. Those burdens for preparing to conduct shipboard operations, or maintaining currency while underway

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<sup>31</sup> Fozard, 83.

<sup>32</sup> Fozard, 83.

<sup>33</sup> HARP, 9.

<sup>34</sup> The value of the conduct of FCLP's at sites other than those designed for it is suspect due to their relevance for meeting the training burden of the requirement. The currency limit from 15 to 29 days for FCLPs is up to the discretion of the C.O., but is normally waived by requiring Case III recoveries (which will be explained later).

with the MEU (SOC), are, at the least, restrictive, and are usually at the expense of some level of combat competency. That expense is based primarily on the inane requirement to keep repeating the FCLP process while embarked, and sometimes regardless of how current the pilot's flight time is.

Looking at the Royal Navy model, combat skills competency is never a problem because there is no written day currency limitation while embarked other than meeting the day- shore based, rolling three-month, minimum flight hour requirements.<sup>35</sup> Each flight, therefore, is dedicated to tactical training, never shipboard currency, with the clear understanding that the pilot will be able to return to the ship and make a vertical landing just as he would at a shore base. However, depending on a pilot's individual currency or lack thereof, the flight authorizer may subjectively impose poor weather or sea state restrictions on the recovery period to allow for a benign environment for landing.<sup>36</sup>

Another concern that tends to hamper the efficient use of tactical training time within the squadron is the qualification of V/STOL LSOs to fulfill the requirement set forth by the *V/STOL LSO NATOPS*. Within that requirement is the recommended minimum numbers of LSOs established for the groups, squadrons, and detachments. Since the detachment is certainly concerned with shipboard operations, those requirements will be listed here: one training LSO, one advanced LSO, one basic LSO, and two LSOs under training.<sup>37</sup> Again, these are the minimums recommended. Most detachments strive for an even greater number of qualified LSOs as it facilitates more

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<sup>35</sup> JSP 318, *Military Flying Regulations* (London: Command of the Defense Council, April 1992), 105-11.

<sup>36</sup> The flight authorizer is the competent and legal authority used to approve any flight. He may be the part of the mission or just made familiar with its details in order to "authorize" each member within the flight.

<sup>37</sup> A training LSO reflects the attainment of the highest level of qualification and experience gained as an LSO. A basic LSO has satisfactorily completed all of the LSO training and is qualified to carry out the duties of an LSO. An advanced LSO has completed an extended shipboard deployment as an LSO,

flexible day-to-day planning for flight operations, because LSO duty conforms to the same duty day limitations as flying.

In order to qualify as a basic LSO, a pilot must be nominated by the squadron commanding officer and, as a minimum, be a designated section leader who is shipboard-qualified. Incidentally, one of the primary considerations for recommending individuals should be time on station remaining, because the *V/STOL LSO NATOPS* manual states “LSO training can be a very lengthy and expensive process.”<sup>38</sup> That expensive “process” consists of monitoring 100 FCLP passes, controlling 100 FCLP passes, and controlling one entire day FCLP period. These are the requirements to become a “field qualified” day LSO. To qualify on the ship, the LSO under training must conduct the brief for the FCLP period, monitor fifty passes, control fifty passes, and then control an entire day evolution from beginning to end. Upon completion of those requirements and with a recommendation from the squadron or training LSO for signature by the MAG/MAGTF commanding officer, the LSO becomes qualified to control aircraft in that capacity. For accounting purposes, this totals 300 passes plus control of one FCLP period and one CQ period for the qualification. If only one LSO were required to be trained, a T/O squadron of pilots (24) flying their minimum of eight passes for an initial FCLP qualification would not generate enough “training” for a single field LSO qualification. As for the carrier qualification, thirteen pilots would have to qualify to their eight-landing initial minimum to produce the 100 passes required; thereafter, another whole CQ period would have to be executed in addition to that in order to meet the shipboard requirements. That would most likely entail in excess of twelve hours of committed deck time to facilitate

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conducted shipboard phase training, and controlled aircraft in heavy sea states, case III and nonstandard recoveries.

that evolution, and that is to just qualify one LSO. Due to the normally high squadron turnover rates, the training and qualification of at least one LSO is required prior to any MEU deployment. There are many other instructor/supervisor qualifications required to support the tactical tasks, but the LSO qualification far exceeds the sortie generation requirement for any of those other qualifications. Somewhere in the intent of the program, an LSO qualification is supposed to happen as a matter of routine during periodic shipboard training cycles. That, however, rarely happens and, as a result, the aforementioned requirements become a true burden to the squadron that is trying to prepare a MEU detachment for deployment.

The U.S. Navy uses an approach that is heavily loaded on the front end with formal classroom training, but then as it moves to the “on-the-job” phase, it becomes much more subjective regarding the structure and the length of training. Its course requires the observation of hundreds of passes, no doubt, but it is astute enough to not tie the qualification to hard numbers that would make an already difficult process even harder to manage. Instead, the U.S. Navy relies on the experience of its training LSOs to determine if and when an LSO candidate is ready to be qualified.

As another counterpoint, the Royal Navy conducts its LSO business very differently as well. It does not have a formal LSO syllabus at all. For day operations, the syllabus is desired but not required, and it is not guaranteed that a member of the ship’s Air Department on duty during any given recovery is a Sea Harrier pilot. Basically, it is the pilot’s own responsibility to ensure his safe recovery back aboard ship. This is not an unrealistic attitude provided the difference between CTOL recoveries and V/STOL recoveries is observed. However, as conditions become less benign, the LSO

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<sup>38</sup> NAVAIR 00-80T-111, 16-1.

representation in the tower is understood to be critical in aiding the pilot back to a safe landing. That does not mean that there is any formal training or qualifications to be pursued. Rather, their non-formal training is a mentoring session, in which a junior pilot accompanies an experienced pilot during LSO duty for an undetermined period of time before the junior pilot can be expected to do it alone. Can the USMC adopt such a system? This is not likely, because the Royal Navy's method is a small, informal system tailored to a very small population of pilots familiar with each other's capabilities and weaknesses. The British experience is valuable, however, in illustrating that the USMC's requirements may be too severe for its own purposes. That severity habitually results in non-compliance or waivers, as we try to follow the requirements as they stand today. To continue the LSO training program as a formal program is a necessity, but a more subjective qualification could greatly reduce the training burden and validate what is already being done in some cases. That is the program that the U.S. Navy uses - formal but subjective in its requirement for experience.<sup>39</sup>

The V/STOL deck launch will be the final area reviewed to complete this investigation into the reasons to change. The focus in this section will be the short take off (STO), as it is the most likely launch type to be used operationally while embarked. There is no reason to believe that STO launch techniques and training are not being taught and that supervision requirements are not being met. Rather, this argument is highlighted to address the issue that the emphasis on the launch as presented by the *V/STOL LSO NATOPS* may not be as strong as it should be.

The STO is more critical than the vertical take off (VTO), with narrower margins for error in a given situation, and the STO launch is primarily used to increase the

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<sup>39</sup> LCDR Robert Bennett, USNR, U.S. Navy LSO VFA-204, e-mail interview by author, 17 October 2001.

aircraft's maximum take-off weight, as a 500-foot deck run into a 30-knot WOD will roughly double the VTO payload.<sup>40</sup> The deck launch aspect, in fact, can be tied to all of the discussions to this point. The connection is not based on the shipboard STO's similarity to land operations, but on its differences, coupled with its reduced margins for success. First, a deck-launched STO is predicated on several factors to ensure its success, varying from an individual aircraft's performance, to the current deck environmental factors, and, lastly, to pilot procedures and technique. Common sense suggests that pilot training and practice can only affect the pilot's procedures and techniques, and that is true. However, the first two requirements, the individual aircraft's performance and current deck environmental factors are used to calculate the critical parameters to effect a safe launch. Those requirements must be calculated by the LSO, who is the only person in the launch cycle who has all of the current information at the time of the launch that can ensure that the launch will be successful, assuming proper pilot technique is employed. Therefore, calculating and supervising a STO deck launch becomes a critical requirement for the V/STOL LSO. This is a significant difference from the CTOL LSO, who is only concerned with the recovery of aircraft, because a CV launch is an automatic affair that either works or does not based on the status of the catapult and the aircraft. The physical and environmental factors for a conventional launch, such as aircraft weight and WOD, are coordinated from the tower and therefore the LSO is not required to generate input.

A shipboard STO is not the same as a normal field STO. Rarely, even including forward site and road operations, is a Harrier forced to take-off in less than 800 feet, except aboard ship. That requirement usually demands a refinement in the WOD in both

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<sup>40</sup> Fozard, 85.

direction and magnitude. That, coupled with a totally pilot-controlled technique, allows the aircraft to launch safely. There is little to no margin for error either in the performance calculations or technique. Those factors alone set it apart from the CTOL catapult, which has much less restrictive wind direction requirements and very little pilot input until the aircraft is airborne. Additionally, if any Harrier pilot is asked about his recollections of class A pilot error mishaps on the ship, he will say that, of the few that exist, they are from the launch and not the recovery.<sup>41</sup>

Surprisingly, there is no specific language in the *V/STOL LSO NATOPS* that requires any minimum number of STOs to be performed during a pilot's initial qualification, or currency. There are also no objective requirements for LSOs under training to calculate, monitor, or control any minimum number of shipboard STOs. Typically, as mentioned earlier, the STO is the preferred method to get airborne from the ship, even during carrier qualification. Normally, in the course of CQ, a pilot would be expected to log the same number of STOs as landings. Likewise, an LSO under training would have the opportunity to monitor and control STOs and landings during the same period. However, if one can agree that the STO requires the most restrictive environmental requirements, exact technique, and close supervision, then why is it not more heavily weighted, by name, in the pilot and V/STOL LSO training and currency requirements? It has to do with our use of the U.S. Navy's *LSO NATOPS* as a model for the V/STOL version. Since the conventional LSO community does not address launches at all, the V/STOL community has not had the impetus to generate the focus on STO deck launches that they deserve. The adoption of the CTOL *LSO NATOPS* framework

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<sup>41</sup> This subject can be rationalized with an example of a single year's mishap rates that will be discussed in the next chapter to support the resistance to change, page 39.

and its effect on the Harrier forces' resistance to change will be analyzed in the next chapter.

## ***CHAPTER 5***

### ***THE RESISTANCE TO CHANGE***

The reasons to change appear clear and tend to support the main overriding concern, which is to provide a reasonable and realistic balance between shipboard and tactical training based on the inherent adaptability of V/STOL to shipboard operations.

The resistance will fall into two categories, legacy and perceptions. The legacy lies purely in the USMC's regard of the U.S. Navy and the latter's use of fixed wing carrier-based aircraft. The Harrier community tends to look to the U.S. Navy for guidance and validation for executing sea-based operations. However, this reliance on the U.S. Navy adds to the confusion of the differences in finding and flying around the ship and landing on it, as related to night and poor weather operations. Perceptions which intertwine with the legacy involve a concept referred to as the "V/STOL penalty," which is an uninformed institutional opinion that V/STOL operations greatly increase mishap rates, whether ashore or afloat.

The *V/STOL LSO NATOPS* is a close duplication of the *LSO NATOPS*, which was adopted by the U.S. Navy to standardize the shipboard qualification criteria for sea-based aircraft. This fact was confirmed by Colonel W. R. Jones, USMC (Ret.), when he stated

that between 1981 and 1983, Harrier squadrons began to do formal work-ups for shipboard deployment, but had no structured syllabus to follow or manual to use as a reference.<sup>42</sup> He and two other officers requested and received NAVAIR funding to publish a V/STOL version of the *LSO NATOPS* designed to fill the void in preparing for and executing V/STOL shipboard operations. That first version was indeed produced by using the CTOL version as the example.<sup>43</sup> Although the V/STOL version is obviously directed toward Harrier operations, it is contained within the same structure as the CTOL version. This includes such topics as the conduct of FCLP, operating conditions, ship-landing qualification and refresher requirements, emergency procedures, and pilot performance records. These topics are valid; however, the “mindset” of conventional carrier operations from a CTOL perspective seems to have carried over into current V/STOL operations at sea. In this mindset lies a very strict system used to bring fighters, that recover at around 120 knots, back aboard a ship through the aforementioned 10 X 30 window.<sup>44</sup> Very little of that applies to a V/STOL recovery, and a break from this mindset might go a long way to recover the efficiency that V/STOL operations aboard ship have historically produced without compromising safety. To emphasize the argument that we are bending over backwards to emulate the procedures for CV operations by copying their *LSO NATOPS*, one only needs to analyze the links between the level of effort, or margin for error, from a CTOL launch and recovery to a V/STOL launch and recovery aboard ship. For example, the CTOL recovery has a very narrow approach window and requires strict aircraft parameters to be held until touchdown;

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<sup>42</sup> Col. William R. Jones, USMC (Ret.), MAG 32 C.O. and former V/STOL LSO, interview by author, 10 January 2002.

<sup>43</sup> Col. Jones.

<sup>44</sup> Fozard, 85.

conversely, the V/STOL recovery has much wider latitude for both. However, for launch, the tables are turned, and the CTOL catapult is deemed simple, whereas the STO is very critical and has a narrow margin for pilot error. With this short argument, it is easy to understand that the Harrier community tends to favor emphasizing the recovery, over the launch just as the U.S. Navy does, because that is our legacy.

The ability for a CV to project power – its main mission - lies in its aircraft, mostly jets that are required to launch and land in waves of 25 to 35.<sup>45</sup> An L-class ship, in contrast, has a multi-mission role and usually will only have four jets airborne at any given time. Even with the complexity of helicopter operations running concurrently, the air department's workload on an L-class ship will never reach that of a CV. Moreover, the larger deck creates a much larger training burden for everyone from the pilots to the deck crew.<sup>46</sup> The large requirement for training is the genesis of the *LSO NATOPS*, which as mentioned earlier, is a very comprehensive manual. While it is a good model to use, one must remember that it is designed to implement procedures to cover different and more complicated events. To further emphasize the legacy barrier, the following statement is found in the 1995 V/STOL Operational Advisory Group (OAG):

The CV *LSO NATOPS* is more restrictive than the V/STOL *LSO NATOPS*. Flying tactical jets around the boat is similar, [so] there probably should not be any major discrepancies between the two.<sup>47</sup>

Blanket statements such as these not only point to a legacy problem when trying to differentiate the Harrier and shipboard V/STOL from CV operations, but they also help to foster a daunting resistance to change. As evidence, this particular OAG topic led to

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<sup>45</sup> LCDR Bennett.

<sup>46</sup> LCDR Bennett.

<sup>47</sup> V/STOL Operational Advisory Group 1995, *LHA and CV NATOPS Comparison item OAG95-406*, 24 October 1995.

the current edition of the *V/STOL LSO NATOPS*, which is now even more restrictive in regards to some currency requirements than the CV version. This is not the direction we need to be moving, because V/STOL ship operations are and always have been different, and in most cases less complex, than CTOL carrier operations. Nowhere is this more apparent than in the Harrier shipboard trials, because the most important aspect of all of the ship deck experience gathered in those early operations was the fact that no changes were necessary to either the aircraft or piloting techniques from the standards and procedures used when flying from land.<sup>48</sup> The Harrier is the only modern, fixed-wing, aircraft for which that claim can be made. How is it possible for a jet aircraft to use the same procedures used to land ashore to land at sea, in what is considered the most demanding environment known to aviation? The answer lies, perhaps, in this passage from *Jump Jet*, which refers back to the criticality of the “gate” for conventional carrier pilots, as opposed to what is required for a Harrier pilot:

Deck landing accidents have long been related to approach speed. The fact of naval aviation life, which encouraged the development of arrestor gear, angled decks, and mirror landing sights and other complex deck aids. The precise point through which the naval pilot must aim on is final approach to the deck is known as the “gate.” He must hold a precise speed of up to 130 knots, and keeping a precise heading, he must pass through this “gate”...Imagine what it is like when the deck is pitching and rolling at the same time. It is clearly not a job for the fainthearted or the unskilled, but the adrenalin that conventional fixed wing pilots expend on deck landing, the Harrier pilot can save for combat. In the decelerating transition from wingbourne to hovering flight, he does not even have to aim at the ship. Errors of speed can be corrected by adjusting the length of the transition to the hover. In the final hover, if the deck is partially blocked, the Harrier can “air-tax” to a clear part of the deck. Kinetic energy, the energy associated with motion, has always been the problem in recovering heavy aircraft at sea. The Harrier gets rid of that energy, before it lands, not after it has hit the deck.<sup>49</sup>

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<sup>48</sup> Fozard, 83.

<sup>49</sup> Myles, 216-217.

The greatest difference between the V/STOL environment and the CTOL environment would be in the final approach and landing itself. The historical documents referenced above have related to this subject, but the following passage by LCDR Robert Bennett, a U.S.Navy F-18 pilot, qualified LSO, and former Sea Harrier exchange pilot with the Royal Navy, provides an additional perspective to consider. His perspective bears on the differences in training, particularly with regard to landing at sea, which V/STOL pilots require as opposed to those flying in conventional carrier operations. According the LCDR Bennett:

In exploring the difference [between landing a Sea Harrier and an F-18 onboard an aircraft carrier], the logical place to begin is the basic manner in which the aircraft is flown. In conventional carrier operations, the pilot is taught early on to always fly his approach at optimum angle of attack (AOA), holding this condition all the way to touchdown. In practical terms, this means that airspeed must be held within + or - 5 knots, the attitude of the aircraft must be held within + or - 2 degrees of pitch while the control rate of descent within a tolerance of roughly + or - 50 feet per minute. Thrust must be continuously adjusted to hold optimum AOA. The pilot is taught to religiously fly this AOA throughout the approach and to be capable of making the required changes to rates of descent without varying the AOA or the aircraft's airspeed, all the while responding to changing conditions. Flying optimum AOA ensures two things: first, that the closure airspeed does not exceed the ability of the ship's arresting gear engines to stop the aircraft and, second, it ensures that the tailhook and main gear impact the deck at roughly the same moment. Too shallow an AOA could mean the hook flies over the wires with the main gear on deck, too great and (sic) AOA could mean the tailhook engages the wires while all landing gear are still in flight, a potentially disastrous condition.

V/STOL flying does not require anywhere near the same technique. AOA must be monitored within wide limits, but absolute precise control of AOA or airspeed is not required. This greatly reduces training requirements.<sup>50</sup>

The demanding set of circumstances, coupled with the small window through which the pilot must maneuver, define the amount of FCLPs that are required prior to

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<sup>50</sup> LCDR Bennett.

attempting carrier qualification. The FCLPs allow a pilot to practice maintaining his AOA while flying to a precise point for landing in a benign environment. While the benign environment is good for accepting large errors without penalty, it is not very representative of the shipboard environment. LCDR Bennett adds that “the training value is reduced by the fact that the landing site is immobile, is not elevated 60 feet above the surrounding terrain, and never comes close to duplicating the often-fierce swirl of winds that exist behind an actual CTOL ship.”<sup>51</sup> He also stresses that, on the contrary, the differences between the V/STOL carrier landings at sea or FCLPs on land are by no means as great as those of conventional aircraft. In his experience, in fact, “shore-based V/STOL landings on a small pad accompanied by some degree of headwind are quite similar to shipboard V/STOL landings.”<sup>52</sup> In addition, as John Fozard reminds us, “The Harrier ‘gate’ is much wider during approach. The subsequent transition is not particularly critical in respect of height or track. All necessary corrections can be made to eliminate errors in the final hover.”<sup>53</sup> Given these points, and with the differences being so clear, it seems appropriate to disassociate the legacy V/STOL training and currency requirements from those of the CTOL requirements, to be replaced by a new, more relevant and less imposing, set of standards that reflect the differences in difficulty between the two.

The Royal Navy, for its part, has adopted a very different approach to establishing its guidelines for V/STOL operations at sea. It had a multi-year hiatus in fixed wing operations at sea, which meant that it could not draw on the vast amounts of experience that it would have had if the Sea Harrier had been introduced slowly as a one-for-one

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<sup>51</sup> LCDR Bennett.

<sup>52</sup> LCDR Bennett.

replacement of its CTOL squadrons. It was not hampered by a lack of previous experience; rather, it was free from any potential misguided legacies. Since the Royal Navy acquired its aircraft specifically to deploy on the new smaller aircraft carriers, it fully intended to take advantage of the efficiencies that the new concept of V/STOL would provide. In general terms, V/STOL would allow the Royal Navy to operate a more flexible force that could concentrate its efforts on a more relevant and focused training model geared toward the tactical mission. Within the scope of this discussion, that intent would be embraced by the Royal Navy's ability to separate the new demands and requirements from those of the previous CTOL experience, thus allowing the Royal Navy to approach the table with a "clean slate" when it came time to write the V/STOL shipboard training and currency requirements. Taking the adaptability of V/STOL to heart and applying this to operations afloat, the Royal Navy's requirements, or lack thereof, are listed below.

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SEA HARRIERFA 2 – EMBARKED OPERATIONS – PILOT QUALIFICATIONS

1. Sea Harrier (SHAR) pilots are to be qualified for embarked operations in accordance with the following:
2. Embarked Day Flying – RN Front-Line Squadrons
  - a. Pre-embarkation Requirements – Ab Initio Pilot
    - (1) A monthly minimum of 10 sorties which should include 5 ski-jump/dummy deck launches/ recoveries.
    - (2) Thorough briefing on flight deck operations and recovery procedures.
  - b. Pre-embarkation Requirements – Pilots with previous FW Experience in Embarked Operations
    - (1) The monthly minima in the training directive apply and are to include ski-jump/dummy deck launches/ recoveries whenever possible.<sup>54</sup>

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<sup>53</sup> Fozard, 82.

<sup>54</sup> JSP 318, 105-11.

These requirements define an extremely minimalist approach, as is apparent by the lack of any dedicated sorties toward CQ. Furthermore, these training standards are followed by, a very capable yet small cadre of pilots that are continually aware of each other's capabilities and limitations of the individual. Based on that last factor, the much larger USMC Harrier force probably does not lend itself to quite so few restrictions. However, the Royal Navy's method does support the argument that V/STOL shipboard operations, training, and currency requirements can be more straightforward and less complex, and that we should explore other models instead of just accepting the U.S. Navy's legacy to carrier operations as our own.

In cases of darkness and bad weather, some of the V/STOL currency requirements are more restrictive (i.e., higher weather minimums and FCLP requirements) than the CTOL requirements. Night and poor weather operations have not been mentioned up to this point, because they are an extension of day, fair weather, operations as far as the actual shipboard vertical landing is concerned. That does not mean that the procedures, and therefore the skills required, are exactly the same as in daytime, but there are similarities. This is where the problem of the hazards of finding and flying around the ship are interchanged with shipboard operations as they pertain to effecting safe vertical landings. Flying to and from a ship at sea does involve many risks that are not present during operations ashore. For instance, the ship may be the only place to land, so a pilot must be able to not only find it, but also must be able to see it from a distance and altitude from which he can land. Thus, what becomes important are the requirements for better ship and aircraft systems to assist the pilot to the point in space where he can visually acquire the same reference points used to effect a daytime, fair weather landing. While

they are inter-related, instrument (poor weather) and night shipboard recoveries are two different procedures that will be discussed separately.

Shipboard recovery weather requirements are divided into three categories:

Case I: 3000-foot ceiling and five statute miles visibility or greater

Case II: 1000-foot ceiling and five statute miles visibility or greater

Case III: Below 1000-foot ceiling and five statute miles visibility.<sup>55</sup>

Case I and II recoveries utilize normal day, fair weather procedures for ship recovery. However, Case II requires that the pilot receive radar vectors below the weather in order to arrive at the ship's initial point, which is the point from which he can see the ship and set up for recovery. The approach used for Case III conditions, whether flown self-contained by the pilot or controlled by the ship, is effectively terminated once the pilot visually acquires the ship below the weather and can remain that way until landing. The goal of either of these approaches is to establish conditions where the aircraft is stabilized and properly configured so that when he visually acquires the ship, he can then revert to the standard day procedures to complete the recovery. Up to this point, CTOL and V/STOL shipboard recovery concerns are very similar and should be given similar emphasis during training and for currency requirements.

In the past, there was seldom a mention of instrument or night recoveries with respect to the Harrier. That is not because these recoveries were not executed early in the aircraft's development; on the contrary, history is replete with examples of Harriers recovering in weather conditions that would have normally grounded CTOL aircraft. This fact is best described by a passage from *V/STOL in the Roaring Forties*, dealing with the RN's experiences during the Falkland War of 1982:

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<sup>55</sup> NAVAIR 00-80T-111, *V/STOL LSO NATOPS* (Washington, DC: Department of the Navy, April 1996), 16-4.

For much of the task force's time in the South Atlantic, the weather was almost a second adversary. It was not without good reason, in the heyday of the sailing ship, that these parts of the southern ocean became known as the roaring forties. The flight decks of the carriers were moving vertically at times through 30 feet and the weather produced cloud bases typically [down to] 200 feet and often down to 100 feet during flying operations. Visibility was typically ½ nautical mile and often much less. One Harrier recovered to the deck of the [HMS] *Hermes* in horizontal visibility of 50 meters [on] one notable occasion. The time-honoured carrier trick of dropping flares at intervals into the ship's wake was used, but it was the Sea Harrier's facility to approach the ship using its internal approach aid and Blue Fox radar at part jetborne [slow] closing speeds of a few tens of knots which primarily provided the safety and hence the success in bad weather recovery.

No conventional fixed-wing naval aircraft could have operated with adequate safety in such conditions, thus supporting the claim that the greatest military contribution made by the V/STOL and STOVL aircraft is in the vertical landing phase of operation. In the Harrier, this phase is made safer, easier and more flexible than in any other combat aircraft.<sup>56</sup>

Fortunately, shipboard recoveries were and are safer and easier in a Harrier, because one key drawback not mentioned is that a pilot will most likely only get one or maybe two attempts at the approach and recovery. This means that the approach will be started with only enough fuel to allow the aircraft hovering performance by the time it is required. Depending on the atmospheric conditions and the weight of the aircraft, the maximum fuel weight to perform a hover may not be enough to allow for an additional instrument pattern to be flown should a landing not be made on the first attempt. Fortunately, that problem rarely occurs and is of little concern in a Harrier, as related by John Fozard:

In 30 sec[onds] a Harrier can reposition in hovering flight over distances of order[sic] ¼ mile ( ½ km ). Any clear 80ft. (24m) square of deck is a VL spot. Go-around fuel and the threat of a blocked deck runway do not feature in Harrier flight planning at sea. Jet V/STOL thus makes aircraft recovery at sea very much easier and safer for both the pilot and the ship, compared with conventional naval arrested landing.<sup>57</sup>

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<sup>56</sup> British Aerospace Pamphlet, *V/STOL in the Roaring Forties: 75 days in the South Atlantic* (Titchfield, England: Polygraphic Limited. 1982), 16.

<sup>57</sup> Fozard, 86.

Conversely, the CV has always relied on the capability to launch a tanker aircraft used to refuel other aircraft if a pilot cannot get aboard for any number of reasons. This provides him the flexibility to continue trying, to attempt to find better weather, or to send the aircraft to an in-range divert. The boarding rate for a Harrier, on the contrary, is 100%, due to the ease of the procedure once the landing spot is visually acquired.<sup>58</sup> The lack of a tanker aircraft, therefore, even from the early days when the aircraft was more challenging to fly, has never been a problem. The two questions that emerge from this discussion are:

1. Why are the day and night weather minimums for currency higher for V/STOL than for CTOL?
2. Why are there night field FCLPs required for V/STOL and not for CTOL?

The two concerns that could possibly account for higher or more restrictive V/STOL weather minimums for the currency requirements would come from a concern for the L-Class operating environment, which means higher safety margins are required to compensate for less than the precision equipment and its operators. Also, as mentioned earlier, the Harrier pilot must be able to visually acquire the ship in order to realize the 100% boarding rate, and he probably only has fuel for two attempts. In addition, the minimum ceiling is raised for recurrency training to ensure that the ship can be visually acquired earlier to allow for a controlled decelerating approach. A former wing commander, indeed, claims that the ship's personnel and training are sub-par to that of a CV, and the Harrier Review Panel maintains that both surveillance and precision

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<sup>58</sup> The 100% boarding rate is based on landings made once the aircraft has transitioned over the ship's deck.

approach radars are “unacceptable by U.S. Navy carrier standards.”<sup>59</sup> The first claim is subjective and debatable, but can be attributed to the aforementioned problems with the L-Class ships’ multi-role nature. The second claim is real, and is another factor that can be attributed to increasing the minimum weather requirements for currency over that of CTOL operations of the CVs.

Night recovery is based on either the Case III (same as the instrument recovery) or on a Case I profile, Case I if using night vision goggles (NVG’s). The difference between the instrument recovery and night Case III recovery is that the pilot never really receives any of the normal daytime cues that he gets after visually acquiring the ship. In the worst case, that of a dark, overcast night, there will be no references to the horizon other than what the aircraft instruments provide. To make matters worse, if there is any significant sea state, the movement of the ship, especially roll, can exacerbate the problem of determining where the level horizon is. These are the factors that significantly increase the night recovery workload. Normally, and if within the range of a divert field, an aircraft that does not have a fully operational Gyro platform and a heads-up display (HUD) to give the pilot usable artificial horizon position will not recover to the ship at night. At night, inside a mile, the pilot uses two sets of reference lights to establish a hover over the landing spot. Just as in the day, the recovery aircraft speed has been reduced to match that of the ship, albeit more by procedures than with the eye. As long as the pilot is able to scan his HUD for true horizon positioning, he can use the normal ship positioning cues and hover position indicator (HPI) lights to complete the deck recovery.

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<sup>59</sup> Major Ben D. Hancock, USMC, *The STOVL Joint Strike Fighter in Support of the 21<sup>st</sup> Century Marine Corps*, research paper (Quantico, VA: USMC Command and Staff College, 1997), 14. and HARP, 9.

While instrument and night recoveries in the Harrier community are considered more difficult due to their reliance on the strict adherence to procedures, the final portion, however, more closely resembles a daytime fair weather V/STOL recovery than that of a CTOL recovery. This is where the challenge of finding the ship gets confused with landing on the ship. Why is it, then, that the USMC's night currency requirements are more stringent than those of the U.S. Navy? The *V/STOL LSO NATOPS* requires FCLPs at the CO's discretion after fifteen days, and makes them mandatory after thirty days.<sup>60</sup> On the contrary, there is no FCLP requirement to regain night currency for CTOL aircraft; instead, it is based on their day currency for shipboard landings, unless twelve months are exceeded, in which case initial qualifications become the requirement. The Royal Navy does adhere to a more strict set of training and currency requirements for night operations as well, but its requirements are always updated by day shipboard operations, not by FCLP periods. The only plausible explanation for the different USMC and U.S. Navy's currency requirement is that the FCLPs required to complete the night currency was added to ensure that a minimum amount of flying could be accomplished prior to conducting night operations while embarked with a MEU.<sup>61</sup> During deployments, Harrier pilots were being stretched to their day currency limits, and then only being allowed to fly the minimum number of sorties to update their night currency, prior to having to fly night missions. Therefore, they had very little recent flight time or proficiency in the aircraft before being asked to perform the more intense night mission and night recovery. This is certainly a legacy of recent historical flight time issues for the Harriers while embarked with the MEU. However, it needs to be addressed in some other

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<sup>60</sup> NAVAIR 00-80T-104, *LSO NATOPS* (Washington, DC: Department of the Navy, April 1996), fig 17-2.

manner than by placing false currency requirements into the *V/STOL LSO NATOPS*, where it is perpetuated as a valued requirement and reinforces the resistance to change.

As previously noted, there is a night Case I recovery that can be used while wearing NVG's. This procedure directly leverages the Harriers adaptability in conducting shipboard operations by following the helicopter community's lead for shipboard recoveries instead of that of the CTOL community. This reduces the time to train for night shipboard operations by at least 30%, which allows for more manageable deck planning from the ship's perspective, and obviously helps to address all of the tactical training concerns mentioned previously.<sup>62</sup> This change is fairly recent and is the first of what could be many that help to steer the Harrier community down its own path for shipboard operations, instead of following so closely that of the CTOL community. The Royal Navy, on the contrary, did not have any preconceived notions that forced it to place any unnecessary restrictions on its desire and ability to operate V/STOL aircraft at sea. That factor, along with the lack of any recent conventional carrier legacy to hamper it, is probably what allowed it to be comfortable with a short paragraph in its regulations, where the USMC has many chapters.

The largest perception problem not relating to the legacy of CTOL carrier operations is the perception that shipboard V/STOL operations carry with them a very high mishap rate. This perception is reinforced by an excerpt from the discussion of the 1995 V/STOL OAG subject, *USMC Embarked Mishap Rates*:

...[the] USMC's embarked mishap [rate] during 1995 was 14.14, eight times as high as the ashore rate of 1.7. In FY1995 [the] AV-8 had 2 class

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<sup>61</sup> LtCol John S. Walsh USMC, V/STOL LSO, telephone interview by the author, 11 January 2002.

<sup>62</sup> Major Kirby A. Stokes, USMC, MAG-14 LSO, e-mail interview by the author, 15 January 2002.

A mishaps embarked.... Procedures must be implemented to reduce the hazards associated with shipboard operations.<sup>63</sup>

What that statement and misdirected concern fail to recognize is that these two mishaps alluded to occurred during what the Safety Center classifies as takeoff, the first one being miles from the ship on departure (possibly not related to the shipboard environment at all), and the second concerned STO procedures. As previously mentioned, the concern for the lack of importance attached to the STO has already been raised as an issue in the “Reasons for Change” chapter. Broad statements and generalized mishap rates can be very misleading, and when taken out of context lead to misdirected actions such as increasing restrictions where they are not warranted. Important to remember is that this is the same OAG that recommended that the *V/STOL LSO NATOPS* should not be any less restrictive than the CTOL version. Additionally, this perception is further reinforced by a common idea that most Harrier mishaps are a result of V/STOL operations, the “V/STOL penalty,” which one would believe was valid for shipboard operations as, Harriers require vertical landings when recovering aboard any ship. However, from the statistics gathered by the Harrier Review Panel and published in its first annual report, this is not supported by the facts: “Although the V/STOL penalty is a distinct and measurable piece of the AV-8B mishap story (at approximately 1 per 100,000 hours), it is not a major rate driver and currently appears under control”.<sup>64</sup>

Historical examples are useful in correcting or contradicting the negative perceptions. Reviewing the Harrier’s record from its inception until 1978, Harrier

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<sup>63</sup>V/STOL Operational Advisory Group 1995, *USMC Embarked Mishap Rates item OAG95-401*, 24 October 1995.

<sup>64</sup>HARP, 5.

squadrons operated from eighteen naval ships, ranging from the nuclear aircraft carrier (CVN) *USS Eisenhower* to the LPD class, and they did so without a single deck accident, as is related by Harrier author Francis Mason:

By way of ending this brief summary of the AV-8A's service with the U.S. Marine Corps, it is perhaps worth quoting the most extraordinary single statistic relating to the operation of Harriers from naval vessels – of which by far the greater proportion has to date been undertaken by the U.S. Marine Corps. It is that in ten years of operational deck sorties, such missions have exceeded 10,000 without so much as a single deck accident, much less an aircraft loss. No other aircraft in the history of naval aviation has come near to approaching this astonishing record.<sup>65</sup>

“Perception is reality” and that can be very difficult to change. However, I believe that such conventional wisdom can be changed, and maybe is beginning to change already, as in the case of the night Case I operations. However, until they all have been addressed and changed, perceptions will continue to contribute to a large portion of the resistance to change.

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<sup>65</sup> Mason, 119.

**CHAPTER 6**  
***THE ABILITY TO CHANGE***

As pointed out in the previous chapters, there is a clear need to change the present V/STOL shipboard operating procedures even though the change will probably be met with substantial resistance. The ability to change is proposed, not to be prescriptive to the Harrier community in its training for shipboard operations, but instead to be descriptive in addressing some of the reasons to change.

The USMC can accomplish this change by first having a clear understanding of what it is that we are trying to accomplish. In this case, we are trying to provide fully trained and tactically proficient aircrews that can also perform V/STOL operations at sea while assigned to an embarked MEU (SOC). The USMC should identify what areas the Harrier force can reshape in order to avoid any compromise of training for its primary tactical core tasks.

To address training, the USMC must first analyze the historical aspects of V/STOL operations afloat, which initially exploited the Harrier's adaptability to sea basing. This was possible because the initial USMC Harrier squadrons were not burdened by the costly training evolutions perpetuated by the emulation of the CTOL Navy, as it is today. Initially, the Harrier force was a small, tight-knit, group of hand-picked pilots, much like in the Royal Navy today. What was lacking in regulations and restrictions was compensated for in individual ability and common knowledge of each other's strengths and weaknesses. As the force expanded, there was a need for a formal and standardized method to conduct V/STOL operations at sea. The Royal Navy used the best guide that was available to it at the time to create a structured syllabus that probably did not have a major impact on the amount of training time devoted to the tactical mission at the time. It was a simple case of using a quantitative approach, as there was no demand to refine it qualitatively. Today, however, the USMC has the problem of training for an ever-increasing number of missions and tasks, which must be precisely balanced with the finite time and resources available for them. Therefore the USMC must leverage the aircraft's increased performance and ease of control with a more flexible training and currency system that allows us to retain all of the efficiencies of V/STOL afloat without detracting from the real, and increasingly complex mission, and the tasks associated with the same. After all, the first deck landings in 1963 made the test pilots and engineers realize that there was a real possibility to reduce the standard training burden for operating afloat.

By understanding the environment better, and with over twenty years of shipboard operating experience, the Harrier community should be able to maximize its V/STOL

operations afloat. Certainly, we now understand that once the pilot has visually acquired the ship, the procedures for landing on it are much less stringent than for that of a CTOL pilot. By considering that observation as well as the more modern, stable, and powerful version of the aircraft, I believe that the assumption of risk for V/STOL operations afloat has decreased to a level where the training and currency burden can be reduced without concern.

I would like to emphasize how the night Case I recovery, mentioned earlier, incorporates these principles and creates a strong argument for the ability to change. First and foremost, it is a procedure that completely distances the Harrier community from the CTOL community. Second, it capitalizes on the upgraded aircraft and its systems to significantly reduce the training time for night carrier qualifications that have historically created the largest burden when working up for MEU deployments. That change will hopefully go a long way to improve the perceptions of how shipboard training and the maintenance of currency should be handled. In fact, by using that change in procedures as an example, one could infer that the day qualification should be de-emphasized because it is certainly easier than doing the same recovery at night with NVGs.

I will end this chapter with a reference to the possible future instead of relying on the past for emphasis. The Royal Navy, with its fresh start and practical approach which it used to fully exploit their V/STOL aircraft at sea, is itself approaching a dilemma, as it may be forced to return to a CTOL carrier aircraft if the STOVL JSF does not materialize. Realizing this as a distinct possibility, the Royal Navy has commissioned several studies to evaluate the effects of such a transition. From these studies, the

overriding concern and primary detractor to transitioning back to a CTOL carrier force is the increased training evolutions and flight time requirements projected to support carrier qualification and currency with the new aircraft. Perhaps when referring to shipboard air operations we can start calling this the “CTOL penalty.”

## *CHAPTER 7*

### *CONCLUSION*

The current V/STOL shipboard training and currency requirements do not maximize the use of limited manpower and operational flying time with respect to the highly technical, mission oriented, tactical core skills training. There are historical elements that contribute to this situation as well as adherence to perceptions that either were or are now invalid for the current conditions. However logical and sensible these measures may have been or seemed to be up to this point, the current standards can and should be changed to more closely reflect the modern capabilities and requirements of today’s V/STOL and tomorrow’s Short Take-Off and Vertical Landing (STOVL) force.

As stated in the previous chapter, the intent has not been to provide a checklist of recommendations for change but, rather, I have tried to expose some of the primary reasons to change, and to point out the potential resistances that will obstruct constructive

change from taking place. Historical research indicates how things were done differently in the past and how we have arrived where we are today. Based on my personal experiences with the Royal Navy, there is considerable scope to break down those perception barriers by providing an alternate set of experiences which shows that “our way” is not the “only way” and certainly may not be the “best way.” Finally, as seen, one recent change preserves some of the investment in the time spent for conducting night carrier qualification, which directly addresses the primary focus of this paper and indicates the feasibility of change. Typically, the first step is the hardest to take when institutionalizing change. Now that this step has been taken, it is imperative to consider and implement some additional meaningful changes to disassociate our shipboard training and currency with that of conventional aircraft in order to release valuable training time for the tactical mission, and to thereby achieve the full maximum potential of the USMC’s Harrier community. By burdening today’s V/STOL and tomorrow’s next generation STOVL aircraft with the “CTOL penalty,” effective combat power is and will be minimized, while the risk to our warriors is maximized.

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