Table 2-7 lists aircraft that comprise more than 90 percent of total USAF combat losses in SEA. The combat sortie data in the table was used to calculate the loss rate per 1000 sorties for each aircraft type:

<table>
<thead>
<tr>
<th>Aircraft</th>
<th>Total Combat Sorties</th>
<th>Losses</th>
<th>Losses per 1000 Sorties</th>
</tr>
</thead>
<tbody>
<tr>
<td>F-4</td>
<td>496,670</td>
<td>382</td>
<td>0.769</td>
</tr>
<tr>
<td>F-105</td>
<td>159,795</td>
<td>334</td>
<td>2.090</td>
</tr>
<tr>
<td>F-100</td>
<td>360,665</td>
<td>198</td>
<td>0.549</td>
</tr>
<tr>
<td>A-1</td>
<td>91,855</td>
<td>150</td>
<td>1.633</td>
</tr>
<tr>
<td>O-1</td>
<td>485,452</td>
<td>122</td>
<td>0.251</td>
</tr>
<tr>
<td>O-2</td>
<td>281,000</td>
<td>82</td>
<td>0.292</td>
</tr>
<tr>
<td>RF-4C</td>
<td>100,050</td>
<td>76</td>
<td>0.760</td>
</tr>
<tr>
<td>OV-10A</td>
<td>123,572</td>
<td>46</td>
<td>0.372</td>
</tr>
<tr>
<td>B-57</td>
<td>43,772</td>
<td>40</td>
<td>0.914</td>
</tr>
<tr>
<td>C-130</td>
<td>227,807</td>
<td>36</td>
<td>0.158</td>
</tr>
<tr>
<td>RF-101</td>
<td>39,296</td>
<td>33</td>
<td>0.840</td>
</tr>
<tr>
<td>B-52</td>
<td>124,532</td>
<td>16</td>
<td>0.190</td>
</tr>
<tr>
<td>TOTAL</td>
<td>2,493,934</td>
<td>1,515</td>
<td>0.607</td>
</tr>
</tbody>
</table>

2.1.2.6 Injuries to Survivors/Evaders

Approximately 24 percent of aircrew losses were classified as KIA. Of those not KIA, pre-ejection injuries (typically lacerations, fractures, and burns from exploding ordnance) accounted for about 20 percent of all injuries received during combat losses. Those pre-ejection injuries were highly susceptible to further complications during ejection, evasion, and periods of captivity (see Table 2-8).

<table>
<thead>
<tr>
<th>Time of Occurrence of Combat Aircrew Injuries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-Ejection</td>
</tr>
<tr>
<td>20%</td>
</tr>
</tbody>
</table>

The major single source of non-fatal injuries is the ejection process itself, and the bulk of those injuries are minor. Windblast induced flailing of the extremities produced the greatest number of injuries during the entire escape sequence. Windblast, also referred to as ram pressure or $Q$ force varies with the air density ($\rho$) and the square of the relative wind velocity ($V$) such that $Q = \frac{1}{2} \rho V^2$. Because $Q$ force is a function of the square of the velocity, there is a strong association between

---

39 Streets, p. 5. Minor discrepancies exist between this data and loss data from Granville listed in Table 2-3 or this report.
41 Granville, Table 15.
42 Every (2), p. 10.
ejection at higher airspeeds and a higher proportion of major injuries (Figure 2-11). For a discussion about how aircrew injuries affected rescue and capture rates, see Section 2.1.8.4

Figure 2-11: Severity of Aircrew Injuries by Ejection Speed
(Source: US Navy data from Every [1], p. 9; AF data from Shannon, Table III)

Figure 2-12: Location of Major and Minor Injuries Among USN Aviators Downed in Combat (Source: Every [1], p. 10)
2.1.2.7 Number of Survivors/Evaders per Incident

Figure 2-13 shows the distribution of losses in SEA by aircrew size. Tables 2-2 and 2-3 in Section 2.1.2.2 suggest the average number of S/E per incident were 1.46 (USN) to 1.79 (USAF) aircrew per aircraft lost. When looking only at the part of that population known to be available for rescue (i.e. excluding MIA and KIA), the average numbers of aircrew per incident were 1.0 and 0.93 respectively.

![Figure 2-13: Distribution of SEA Combat Losses by Aircrew Size](Source: Granville, Table 15)

2.1.3 Distribution of Losses

2.1.3.1 Distribution by Threat Level

Table 2-9 describes the distribution of combat losses by service and location. The losses reflect the taskings of the different services, with the US Marine Corps (USMC) supporting its ground operations in SVN, the USN focusing almost exclusively on NVN, and the USAF supporting operations all across the peninsula. By classic definition, perhaps only areas in NVN qualified as “high threat,” however the nature of the operations in SVN and Laos forced aircraft into the low-altitude environment making them vulnerable to AAA and other assorted ground fire (which, as shown in Figure 2-14, were the most lethal threat categories in SEA).
2.1.3.2 Distribution by Range

Until helicopter air refueling became available in SEA, rescue crews had no alternative but to use the FOL at Quang Tri in northern SVN and Lima Sites in northern Laos. At that time, approximately 18.9 percent of cases in which aircrew became POWs were attributed to insufficient range of the helicopter. After July 1966, with the arrival of air-refuelable HH-3s, no

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44 Hewett, p. xii.
The combination of geography and basing options resulted in a maximum rescue radius of about 200 miles. Although aircraft improvements made covering those distances easier, it was aircrew creativity that often made the difference. Consider the description, by an HH-43 Flight Engineer, of how the range limitations of his helicopter were overcome:

"As you know, the HH-43 “Pedro” and the HH-34 “Choctaw” did not have in-flight refueling capability. However, we did put 55-gallon drums of fuel on board and [brought] a wobble pump. As we went along, we stuck the hose from the drum to the outside fuel filler receptacle just outside the door (and reachable by the FE). When the drum was empty, we kicked it overboard. The number of 55-gallon drums we carried was set based on the distance to the pick-up location and weight restrictions. The 43 was designed for [local base rescue] and was assigned that in ‘Nam, but as the war changed, so did we. Over time, the radius of required coverage became larger and larger so, like all good Pedro’s, we improvised. That’s how the first “North of the DMZ” rescues early in the war were performed by the HH-43’s. The HH-34s were likely operated in the same way..."49

Although not a measurement of mission range per se, sortie duration is a helpful indicator of the range (and the pace) of mission execution. The choice of staging locations and alert options (airborne and ground) resulted in average CH-3/HH-3 combat sortie durations of 85.9 minutes. At the extremes, the longest average sortie duration in any given year was 310 minutes by the HH-3 in 1970 and the shortest was 32.1 minutes by the CH-3 in 1965.50

![Figure 2-15: Average CH-3 and HH-3 Combat Sortie Duration by Year](Source: JTCG/ME, Table B-1)

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47 7602 AIG, p. 4.
48 Tilford, p. 82.
49 DaSilva, interview
50 JTCG/ME, Table B-1.
No explanation is given in the Joint Technical Coordinating Group for Munitions Effectiveness (JTCG/ME) reference as to the reason for the significant increase in average sortie durations from 1966 to 1970. One could infer, however, that the increase reflects more frequent use of the orbit concept over time in order to keep response times to an absolute minimum. That supposition is supported, at least anecdotally, by the upward trend of recovery rates during that same time period.

2.1.4 Enemy Reaction to Isolating Incidents

The North Vietnamese and the Viet Cong placed significant value on the capture of downed American aircrew. When the war began, their intention was to capture the aircrew for the goodwill that might be generated by the prisoners' release at a later date. Once they realized the political leverage gained by long-term possession of American POWs, the strategy shifted accordingly. Regardless of their intention, the North Vietnamese and Viet Cong wanted to capture downed aircrew before they could be rescued, and were willing to assign battlefield resources to that end. Once an S/E was captured, the enemy frequently used his survival radio to further confuse rescue efforts.

Very early in the war, North Vietnamese and their Pathet Lao allies became adept at setting up flak traps (sometimes called SAR Traps). The flak traps, ambushes of SAR forces using S/E as bait, were the defining characteristic of enemy reaction to shootdowns in SEA. An excellent example is the case of Wolf 06, an F-4D flying out of Udorn Royal Thai Air Base. In the late afternoon of March 19, 1970, Wolf 06 was brought down by a direct hit from 57-mm AAA during a visual reconnaissance mission over Laos. Separated from his backseater, the pilot hunkered down in a concealed area to await rescue. From that vantage point, he witnessed savvy and methodical enemy construction of a SAR trap that was typical in SEA:

"Enemy activity was astonishing. The minute we were down the enemy started bringing in guns all around our position. They had 37mm, 23mm, ZPU, and small arms. It was obvious what they were doing and it made me furious. They had set their pattern in a crossfire, knowing that the SAR effort would begin in the morning. They fired about 1,200 rounds throughout the evening to make sure their crossfire pattern would cover the area where the Jolly Greens or Sandies would be coming in."

2.1.5 Duration of Survivor/Evader Exposure

Most Combat Rescue attempts, particularly long-distance missions, were a never-ending race with time. In many cases, too much time was required to build an armada to penetrate enemy air defenses and give rescue forces a reasonable chance for success. Key factors influencing the time S/E were available for rescue included distance from friendly rescue forces, enemy population density and sentiment, type of terrain, and amount of ground cover.

Figure 2-16 describes the cumulative status of S/E over time in proportion to the total population that was available for rescue (i.e. excluding MIA/KIA). The data suggest that after the first 60

51 Porter, pp. 45-46.
52 Francis, p. 51.
minutes, enemy effectiveness in capturing S/E was almost completely diminished, while our own ability to successfully recover personnel persisted (albeit at a reduced rate). In general, if an S/E's status changed after the first hour, it was more likely to reflect his rescue than his capture. That trend does not apply when operations in NVN are looked at in isolation. In NVN, the enemy was consistently more effective at capturing our S/E than we were at their rescue, and their performance advantage persisted over time.

The spikes in the “Captured” category at the far right of Figures 2-17 and 2-18 actually represent a disproportionately high number of S/E captured after 48 hours. 4.06% of the IPs were still evading after 48 hours—of these, 78.8% were captured while 21.2% were rescued. We attribute that phenomenon to instances where friendly forces were unable to locate the S/E, leaving them exposed to “accidental” or opportune discovery by the enemy.

![Figure 2-16: Cumulative Status of S/E Over Time (SEA)](source: Total distribution from Granville, p. 57; ‘Rescued’ data from Directorate of Aerospace Safety, Section D; ‘Captured’ data from 7602 AIG, p. 10)
Figure 2-17: Status of Survivors/Evaders Over Time (SEA)
(Source: Total distribution from Granville, p. 57; ‘Rescued’ data from Directorate of Aerospace Safety, Section D; ‘Captured’ data from 7602 AIG, p. 10)

Figure 2-18: Status of Survivors/Evaders Over Time (NVN Only)
(Source: Every [2], pp. 28-9)
2.1.5.1 **Elapsed Time to Rescue**

Most evaders rescued in SEA were recovered in short order. Many factors had a bearing on this, but "probably the most important were friendly control of the air, an efficient dedicated rescue force, and aircrews who knew how to aid in their own rescues." The use of FOLs and the "orbit concept" described in Section 2.1.1.2 significantly improved rescue response times and helped reduce the period of S/E exposure.

Actual experience of survivors/evaders on the ground varied significantly. While some S/Es were forced to evade capture for weeks before being rescued, others were rescued within mere minutes of his feet touching the ground. Causal factors for prolonged exposure were difficulty locating the S/E, and the delay required to assemble a SARTF when the loss was in an area of elevated threat.

Of S/E that were successfully recovered, 35 percent were recovered in the first 30 minutes. At the end of the first hour of exposure, 56 percent of rescues had been accomplished. Only 16 percent had to spend more than six hours on the ground, and that was usually because darkness terminated the rescue effort. Most of these were picked up at first light the next day. After 48 hours, 99 percent of S/Es that were going to be rescued had been picked up.

The influence of threat level on time-to-rescue can be seen in a comparison of land rescues performed in NVN (a traditional high-threat environment) with the overall land experience for combat recoveries in SEA, and with water rescues in the Gulf of Tonkin and South China Sea (Figure 2-19). Although the threat increased as one approached the shoreline, the vast majority of water recoveries were not contested, and might represent a theoretical minimum response time given the equipment and procedures available in SEA.

![Figure 2-19: Time to Rescue in Various Environments/Threat Levels](source: 'Water' from Every (1), p. 30; 'Land' (NVN) from Every (2), p. 29; 'Land (SEA)' from Directorate of Aerospace Safety, Section D)

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53 Air Force Inspection and Safety Center, p. 5.
54 Air Force Inspection and Safety Center, p. 5.
Figure 2-20: Percent of Land Rescues Accomplished Over Time With Data for Years 1963 to 1971\(^{55}\)
(Source: Directorate of Aerospace Safety, Section D)

\(^{55}\) Data for each individual year were included in the figure to highlight the constancy of the rescue rates over time in SEA. It is remarkable considering the evolving nature of the decade-long war, and the changing capabilities of the recovery vehicles and escort aircraft themselves.
2.1.5.2 Elapsed Time to Capture

Once the staging locations and orbit concepts were established, elapsed time to capture was a function of four major variables—S/E injury, intensity of the threat surrounding the S/E, population density of the evasion environment, and distance traveled before ejection after being hit (see Section 2.1.8.3). The cumulative effect of those variables on the speed of capture can be seen in the USN results in Figure 21. The USN experience in NVN is characterized by more severe injuries, higher threat, higher population density, and shorter distance traveled between being hit and the point of ejection.

![Figure 2-21: Elapsed Time Until Capture (by Service)](Source: AF data from 7602 AIG, p. 10; Navy data from Every (1), Figure 13)

2.1.6 Types of Recovery Forces

Multiple, disparate efforts were made in SEA to recover downed aircrew. They ranged from conventional Combat Rescue forces to political pressure to offers of reward for the safe return of our aircrews. Planners had also hoped to establish an underground network of friendly natives in NVN and Laos that would assist pilots (as had the French Maquis in World War II), but such an underground never materialized. 56

Friendly guerrilla units operating in southern Laos and CIA Roadwatch teams were also given a secondary mission of searching for missing and captured airmen. Although the Roadwatch teams operated until the end of the war, recovery of downed aircrew members was only a secondary mission for these teams, and they rescued only a small number of people. In 1968, for example, there were only seven instances in which Roadwatch teams were alerted for possible recovery activity, and in only two cases were teams actually used. 57

Regarding the many methods available at the time, Col William M. Harris, IV, commander of

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56 Tilford, p. 68.
57 Tilford, p. 68.
the 37th Aerospace Rescue and Recovery Squadron in 1971 and 1972, noted, “During my tour rescue efforts have called on every conceivable military resource as well as...Air America, special ground teams, clandestine operations, frogmen, aircraft carriers, tanks, and so on. There is no limitation to tactics or concepts to be employed to effect a rescue.”

But despite all of the options available, and Col Harris’ aggressive efforts to use every means imaginable to recover our airmen, the reality was that the helicopter emerged as the single, best tool to do the job. Helicopters performed 98.6 percent of successful rescues, with ground parties performing the remaining 1.4 percent (see Figure 2-22). Further, the vast majority of recoveries via ground party were not pre-planned recovery missions, but the result of opportune arrival of friendly ground forces in the vicinity of the evader. For rescues performed over water, the helicopter remained the primary means of recovery, performing 86.2 percent of water recoveries. Surface vessels (including ships and amphibious aircraft) accounted for the remaining 13.8 percent of successful water recoveries.58

2.1.6.1 Dedicated vs. Opportune Recovery Forces

In all, about 20 percent of successful SEA rescues were accomplished by opportune forces (Figure 2-23). Early in the conflict, doctrinal considerations made it difficult to send rescue forces into Thailand to support Farm Gate air operations there. Farm Gate was a politically sensitive operation, and the presence of rescue forces would have highlighted the fact that they were doing more than "training" missions. At that time, what Tilford calls the "dark ages of SAR," there was a misconception on the part of some US Army helicopter crewmen, shared by their Marine and Vietnamese counterparts, that rescue “entailed nothing more than flying over a

downed crewman and picking him up.”

Even with the development of a robust, specialized rescue force in SEA, “opportune” rescue forces had a significant impact on recovery rates. As of 1968, the US Army had more than 3,200 helicopters operating in SEA and because of that saturation, “an aircrew member downed in South Vietnam who declares an emergency [could] usually expect to have an Army helicopter overhead within minutes after giving his position.” In all, US Army helicopters were credited with rescuing 238 people from SVN and 2 from Laos (most of these saves occurred when one helicopter moved in to save the crew of a nearby downed chopper). In fact, opportune rescue forces were responsible for the shortest evasion period reported by USAF evaders (20 seconds) when an Army helicopter that followed a pilot during his parachute descent, landed beside him, and made the recovery. An account of one of the more sensational opportune recoveries makes the point that, in a pinch, an evader will be happy to take the first ride home, no matter what it is. Shortly after landing, the pilot was advised by his flight lead that a pair of Army AH-1 Cobra helicopters was heading for the area.

“One set down about 20 yards in front of me but couldn’t spot me and started to lift off. For the first time I exposed myself. I jumped up and waved my arms and started through the mud and slime toward that beautiful chopper. All the time I was expecting to get a bullet in the back. They couldn’t take me inside, since it was a two-seated tandem cockpit, so they dropped a gun-bay door cover and motioned to me to lie down on that and hang on to the skid. It was rather windy riding out there, but I was really relieved to see that Vietnamese countryside going away from me.”

2.1.6.2 Recovery Vehicles Used

Helicopter recoveries in SEA began with 16 Sikorsky H-34 "Choctaw" helicopters sent to Air America in 1961. The rescue vehicles in the 1961 inventory (primarily the H-34 Choctaw and the HH-43 Husky [also called the “Pedro”]) were ill suited for search and rescue in jungles and mountains. Their most appropriate use was supporting rescue in close proximity to the air base and for fire fighting.

By 1967, the primary aircrew recovery helicopters were the HH-43F and HH-3E, "off the shelf" vehicles modified to satisfy the immediate rescue requirements. Each aircraft had its peculiar deficiencies and neither had the speed or range to rapidly reach airmen downed deep inside NVN or Northern Laos and the HH-43F was unable to hover over the higher mountains and karst formations.

When the HH-53 was introduced in late 1967, it became the mainstay of Combat Rescue operations in NVN, leaving coverage of SVN and Laos largely to the HH-3 while the numerous HH-43s in Theater retained their traditional taskings of local base rescue. As early as 1966, the H-3’s deficiencies in combat had been categorized by the aircrew flying them. Stated deficiencies included:
The deficiencies were addressed with newer models of the H-3 that included a 650-gallon fuel tank, and two jettisonable 200-gallon external tanks like those used on the F-100 jet fighter. With those improvements, the H-3 could attain a combat range of 500 miles (depending on loiter time and other operational considerations).\(^{64}\) It also had a 240-foot hoist with forest penetrator.

In the HH-53, the rescue service had an aircraft that, with in-flight refueling, had excellent range, improved defensive systems, and represented the best in rescue technology. Yet there were some limitations in the system. Described in Tilford as “too large to be an ideal rescue helicopter,” its size kept it from maneuvering in tight areas like karst valleys and made it an easy target for enemy gunners.\(^{65}\) Despite the expansion in capabilities offered by the HH-53, “the 3d ARRGp had two primary objections to [the HH-53]: the helicopter was too large and too slow.”\(^{66}\) Pilots complained about the HH-53’s limited field of view and that the position of the rotor mast forced the pilot to maintain a 5-degree nose up attitude during the hover, thus further restricting vision. “[HH-53] crew commanders were also concerned that during a hover the starboard side was not covered by the minigun because if one para jumper was on the jungle penetrator or helping the survivor aboard, and the other was working the winch, there was no one available to fire the minigun.”\(^{67}\)

### Table 2-10: 3 ARRG Aircraft Strength-as of May 1969\(^{68}\)

<table>
<thead>
<tr>
<th>Aircraft Type</th>
<th>Authorized</th>
<th>Assigned</th>
</tr>
</thead>
<tbody>
<tr>
<td>HH-3E</td>
<td>18</td>
<td>20</td>
</tr>
<tr>
<td>HH-43B</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>HH-43F</td>
<td>7</td>
<td>6</td>
</tr>
<tr>
<td>HH-53B</td>
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<td>6</td>
</tr>
<tr>
<td>HH-53C</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>HC-130P</td>
<td>11</td>
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</tbody>
</table>

\(^{64}\) Tilford, p. 70.  
\(^{65}\) Tilford, p. 93.  
\(^{66}\) Francis, p. 51.  
\(^{67}\) Tilford, p. 93.  
\(^{68}\) Overton, p. 3.
Table 2-11: SEA Recovery Vehicle Data

<table>
<thead>
<tr>
<th>Type</th>
<th>HH-43</th>
<th>CH-3</th>
<th>HH-3</th>
<th>HH-53</th>
</tr>
</thead>
<tbody>
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<td>Crew</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Speed</td>
<td>75 knots</td>
<td>110 knots</td>
<td>120 knots</td>
<td>140 knots</td>
</tr>
<tr>
<td>Radius of Action</td>
<td>91 miles</td>
<td>220 miles (unrefueled)</td>
<td>310 miles (external tanks)</td>
<td>290 miles (unrefueled)</td>
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<tr>
<td>Endurance</td>
<td>2+20</td>
<td>3+00</td>
<td>Unlimited with air refueling</td>
<td>Unlimited with air refueling</td>
</tr>
<tr>
<td>Armament</td>
<td>None</td>
<td>1 x M-60 (7.62)</td>
<td>2 x M-60 (.762mm)</td>
<td>3 x GAU-2 (7.62mm)</td>
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<tr>
<td>Armor</td>
<td>HH-43B: No, HH-43F: Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Hoist Capability</td>
<td>210 feet</td>
<td>240 feet</td>
<td>240 feet</td>
<td>240 feet</td>
</tr>
<tr>
<td>Normal Operating Weight</td>
<td>9150 lbs</td>
<td>18000 lbs</td>
<td>18000 lbs</td>
<td>36000 lbs</td>
</tr>
<tr>
<td>Length</td>
<td>25 feet</td>
<td>73 feet</td>
<td>73 feet</td>
<td>88 feet</td>
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<tr>
<td>Combat History</td>
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<table>
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<tr>
<th>Vietnam (NVN)</th>
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<th>Losses</th>
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<td>0</td>
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<td>246</td>
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<td>SVN</td>
<td>9878</td>
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<td>7557</td>
<td>2</td>
<td>.0003</td>
<td>1719</td>
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<td>Laos</td>
<td>9761</td>
<td>9</td>
<td>.0009</td>
<td>5398</td>
<td>5</td>
<td>.0009</td>
<td>0</td>
<td>0</td>
<td>n/a</td>
<td></td>
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</tr>
</tbody>
</table>

The HH-43 flew 7 sorties in Cambodia with no losses
1 combat loss reported during operations in Thailand

The HH-53 flew 177 sorties in Cambodia with 1 loss (.0056 loss rate)

(Discrepancies exist between these combat history data [from Granville Tables 8-11] and that from Table 15 of the same document.)
Sikorsky HH-34 Choctaw

Kaman HH-43B “Huskie”

Sikorsky HH-3E Jolly Green Giant

Sikorsky HH-53D Super Jolly Green Giant
Recovery concepts of operations and tactics evolved quickly in SEA. By 1965, with experienced helicopter and A-1E RESCORT crews, and with the amphibious, fixed-wing HU-16s operating out of Da Nang to cover the water rescue mission, a full SARTF was available in SEA. Over the years, equipment improved and aircraft changed, but the SARTF of 1965 closely resembled that of 1973 in doctrine, tactics, and procedures.

Rescue efforts generally took precedence over normal strike missions (particularly in the war’s later years) and aircraft were often diverted from their assigned targets to support the S/E and rescue helicopters. Battle managers’ willingness to task assets to support Combat Rescue operations was, at times, astounding. On one mission in December 1969, 336 sorties were flown over a three-day period to help rescue forces recover a navigator evading capture near Ban Phanop, Laos, just outside Tchepone. In addition to the A-1 and Jolly Green sorties, the USAF used 50 F-105, 43 F-4, 4 F-100, plus assorted O-1 and O-2 sorties. The Navy also contributed a number of A-6 and A-7 sorties.\(^6\)

Another mission, the rescue of Lt Col Icieal Hambleton, an Electronics Warfare Officer on Bat 21, is perhaps the most famous example of massive airpower used to support Combat Rescue operations, and served as an indication that sometimes the blunt instrument of massive firepower simply is not effective. In March, 1972, Hambleton ejected safely from his damaged EB-66, but landed directly in the middle of a major North Vietnamese army unit sweeping south. A rescue operation was launched that took precedence over virtually all other air missions being flown in South Vietnam, and included eight hundred sorties flown by bombers, fighters, forward air controllers, and helicopters. In the process, six more aircraft were shot down, several others were severely damaged, ten more airmen were killed, and air operations against the massive Easter Offensive were disrupted. Bat 21 would evade capture for twelve days before being rescued by a Navy SEAL, Lieutenant Tom Norris, who received the Medal of Honor for leading a daring and unorthodox boat-borne recovery. Col Jack Allison, a helicopter pilot since 1951 and a veteran of numerous Combat Rescue missions, said “against opposition like that encountered in the Bat 21 mission the traditional SARTF was useless.”\(^7\)

**ON-SCENE COMMANDER**

The term “On-Scene Commander” describes a specific role filled by a player in the terminal area of an ongoing rescue mission. Although any aircraft in the area could assume the role, it typically fell to the Sandy aircraft when they were available. In those cases, one of the pilots in the Sandy Low element acted as OSC. In the terminal area, the OSC determined the location and condition of the S/E, assessed enemy defenses, and marshaled/controlled forces to suppress the threat until it was safe for the helicopters to attempt the pick-up. If Sandy Low required additional support, he coordinated with HC-130 Crown aircraft to redirect airborne fighters to launch fueled/armed aircraft that (depending on availability) were on standby to support the mission. Ultimately, the OSC determined exactly when, and under what conditions, the pickup attempt would be made.

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6 Tilford, p. 96.
7 Tilford, p. 118.
It was not an accident that OSC duties, arguably the most difficult to be found in anywhere SEA, were assigned to Sandy aircraft when they were available. The intense demands of the mission required aircrew that were specifically trained to meet those demands. Inevitably, as described in a Pararescueman's End of Tour report, when the training was insufficient, mission success suffered:

"Another area I feel deserves attention is the coordination and tactics between the A-1 Sandy aircraft and the rescue helicopters....The SAR aircrews felt that it took a number of SAR missions to produce a good Sandy pilot and even more missions to qualify a Sandy lead, which is one of the most important elements involved in a combat recovery. By flying actual SAR missions on a day-to-day basis, these pilots received training that could never be obtained by [previous] pilots that were required to fly four different types of A-1 missions. The lack of mission experience by the A-1s caused errors in timing or mission sequencing. This often manifested itself as indecision on when to bring the Jolly in to attempt the pick-up....A-1's flying solely for SAR support were in the best position to get the type of SAR experience needed. Further lack of A-1 experience led to the development of an over-cautious attitude among the SAR forces."

The importance of dedicated training of rescue forces in Combat Rescue doctrine and tactics, and the value in a primary focus on that mission, was consistently repeated among those that operated in SEA. It is a theme that emerged as universal across all conflicts studied for this report.

**RESCUE ESCORT**

During the course of the war, fixed-wing aircraft used most extensively for RESCORT included the T-28, A-1 and, toward the end of the conflict, the A-7 jet fighter. By 1967 the A-1E had the highest overall loss rate of any airplane in SEA. Skyraider loss rates per 1,000 sorties ranged from 1.1 in SVN to 1.5 over Laos and up to 6.6 for missions over NVN. The high loss rate over NVN was directly attributable to the A-1s rescue escort role. For context, NVN loss rates for the F-105, F-4 and HH-53 were 3.3, 1.6, and 4.1, respectively.

The A-1 was almost ideally suited for the RESCORT mission because of its ability to fly an efficient cover pattern in the helicopter's airspeed regime; they were durable against anti-aircraft fire; and they could carry and effectively deliver a wide range of suppressive ordnance. The enemy had an excellent understanding of the capabilities of different support aircraft, and showed little regard for those that were typically equipped with conventional bombs. On the other hand, they had great fear of the A-1, not only for its special munitions, but also because of the surgical precision of its machine guns, and their effectiveness against individually targeted soldiers.

Normally, four A-1s in two flights of two were used for RESCORT. The elements, referred to as "Sandy High" and "Sandy Low," either flew with the helicopters, or split, sending one element to the terminal area to provide an OSC and immediate protection to the S/E, and holding one element back to support the helicopters as they made their way towards the terminal area. When

71 Farrior, p. 2
72 Granville, Tables 8, 9, and 10.
Sandy Low determined that it was safe for the helicopters, he briefed Sandy High on the situation in the terminal area who then escorted the helicopter designated as "low bird" into the zone. The "high bird" typically remained in a safe orbit, ready to advance if the need arose.

Late in the war, the A-1s were retired from this role and were replaced by the A-7. At the time, rescue helicopter crews expressed their concern:

"The SAR community generally feels the A-7, being a jet aircraft, is not the optimal aircraft to support this mission. The A-7's sustained turn radius is quite small for a jet fighter, but even this radius of turn will occasionally place the escort pilot in a position where visual contact with the helicopter is difficult to maintain. Tests plus combat experience have shown that less than two or three miles of visibility will negate the ability of the A-7 to effectively perform the escort mission."73

The bomb load of the A-7 was theoretically twice that of the Skyraider. However, this was less relevant for the rescue escort mission because the ordnance load typically included special munitions rather than a large load of 500-pound bombs. In the rescue configuration the first three rescue escort aircraft, Sandys 1, 2, and 3, usually carried two CBU-38 cluster bombs, two LAU-3 launcher pods packed with high explosive rockets, and two additional LAU-3 pods filled with white phosphorus rockets. The fourth plane in the rescue escort flight, Sandy 4, carried two CBU-38s and a pair of CBU-12 cluster smoke bombs.

OTHER SUPPORTING FORCES

Beginning in 1970, twin-engine OV-10 "Broncos" began working with the SARTF as forward air controllers (FAC). Because of their speed, armament that included four 7.62mm machine guns as well as a rocket or gun pod, and great visibility, the Jolly Green pilots preferred the OV-10 to the slower, unarmed O-1s and O-2s. The FAC was often the first aircraft in the area and assumed the OSC role until the arrival of Sandy Low. Once Sandy Low arrived, OSC duties were handed off and the FAC assisted by directing fighter-bombers if they were needed. As the number of A-1s was reduced, the role of the OV-10 in the SARTF expanded.

During our involvement in SEA, just about every imaginable combat capability was assessed for its ability to support the rescue mission. The idea of using AC-130 Spectre gunships in rescue work can be traced to an incident in late 1972. In December 1972, an AC-130 was diverted from its patrol along the Ho Chi Minh Trail to help an HH-53 search for the crew of another Spectre gunship shot down over Laos, pinpointing the survivors with the AC-130's night vision devices. The AC-130's effectiveness in support of the rescue mission, deriving primarily from its loiter time, remarkable firepower and ability to do command and control (C2), led to establishment of a Special Operations search and rescue integration training program.74 The AC-130 would not again be seen in such a support role until August, 1995, when the Spectre assisted in the (fruitless) search for Ebro 33, shot down during Operation Deny Flight (see Section 2.3).

73 Every (2), p. 31.
74 Tilford, pp. 135 and 136.
2.1.7 Terminal Area Characteristics

2.1.7.1 Physical Environment

In SEA, 80 percent of USAF parachute landings were made on land while about 20 percent ended up in the water. Almost the reverse was true for the Navy, with 73 percent of parachute landings putting the aircrew in the Gulf of Tonkin, and the remaining 27 percent onto land (frequently near the North Vietnamese coastline, the worst possible location for evasion). Figure 2-24 describes the distribution of landing environments and outcomes among downed USAF aircrew.

Of the land environments encountered, Figure 2-24 also shows that slightly more than half of the S/Es that ejected landed in a wooded area. In almost half of those cases the survivor became hung-up in the trees, some as much as 200 feet off the ground. Figure 2-25 shows the results of tree landings in SEA:
Figure 2-24: Survivor/Evader Evasion Environment
(Source: Directorate of Aerospace Safety, Section C)

Figure 2-25: Results of Parachute Landings into Trees in SEA
(Source: Directorate of Aerospace Safety, Section C)
2.1.7.2 Locating the Survivor/Evader in the Terminal Area

Although data describing how each isolating event was detected does not exist in summary form, anecdotal accounts and sensor technology available at the time suggest that radio calls from the distressed aircraft and wingman were the primary method of notifying C2 centers of a loss. Once on the ground, evaders had a myriad of options for signaling their location. In thick jungle areas, however, most were ineffective. By every account, the survival radio was the most important piece of equipment available to S/E in SEA. Figure 2-26 summarizes the types of signal devices used in the terminal area by aircrew that were successfully rescued.

Figure 2-26: Types of Signalling Devices Used in Successful SEA Rescues
(Source: Directorate of Aerospace Safety, Section H)
Among AF aircrews rescued in SEA, the rescue hoist was the primary means for their extraction from the terminal area (see Figure 2-27). Depending on the time of year and rainfall, even flat areas like rice paddies could require a hoist recovery. Some of the difficulties involved with hoist recoveries in rugged terrain are described in this debriefing of a rescued pilot:

"...I saw that I was going to land in the trees, so I discontinued steering, put my feet together, shielded my face, and prepared for a parachute landing fall or tree penetration. I went through the tops of the trees and my chute hit the trees and hung up, causing a very gentle tree landing. I was six feet from the side of a karst face, and although I could not see the valley floor due to the dense foliage, I estimated it was 100 to 200 feet below me. There was also a ledge of karst about 25 feet below me."\(^75\)

After an H-34 tried unsuccessfully to get a horse collar to the pilot through the trees, an HH-3 equipped with a forest penetrator arrived in the valley. At that point, the recovery continued:

"...the Jolly Green moved in with a PJ on the hoist. The PJ was unable to get to me due to the trees and because the refueling probe of the helicopter forced it to remain too far from the karst face. I used my helmet and oxygen line as a lasso; the PJ grabbed it and reeled himself over to me. The PJ was sitting on two legs of the penetrator and was strapped in, with another strap ready to put around me. He lowered the third seat but I was unsuccessful in getting on it. I felt secure enough from the strap under my arms and did not attempt to use the seat any more. The PJ was on the radio and called to have us raised a foot or two so that he could cut the shroud lines and back pack which were still connected to me. It took ten minutes to cut all 28 lines. He then swung us away from the tree and we banged into another tree before being hoisted up to the chopper."\(^76\)

The problem the H-34 had using a horse collar in a foliated area highlights why the forest penetrator was the extraction device of choice, used in more than 90 percent of the successful hoist recoveries (see Figure 2-28).

Bringing S/Es aboard the helicopter via a landing or while in a low hover were the next most frequent means of recovery (used in 34 percent of cases). Unfortunately, the data do not describe how that 34 percent was divided between landings and low hovers.

\(^75\) Seig, p. 48.
\(^76\) Seig, p. 49.
Figure 2-27: Land Recovery Means Used in SEA Combat
(Source: Directorate of Aerospace Safety, Section C)

Figure 2-28: Hoist Insertion/Extraction Devices Used in SEA Combat
(Source: Directorate of Aerospace Safety, Section C)
2.1.8 Factors Affecting the Rescue Operation

2.1.8.1 Physical Environment

POPULATION DENSITY OF THE EVASION ENVIRONMENT

A study of returned American prisoners of war compared time on the ground for downed aircrew and the average population densities of their aircraft incident locale. The results showed a dramatic difference in evasion potential between the highest and lowest areas of population density. Table 2-12 and Figure 2-29 show comparative evasion times for each population density area and the percentage in each area captured within 30 minutes.

USN experience is consistent with that conclusion. Because most USN aircrew downed over land were in heavily populated areas near the coast of NVN, areas with population densities that frequently exceeded 520 persons per square mile, it should be expected that evasion times or Navy aircrew that were captured would be substantially less than the POW population as a whole. That proved to be the case. Within 20 minutes of landing, 80 percent of USN POWs had been captured, versus 62 percent of USAF POWs (shot down across the entire SEA area).

Table 2-12: Impact of Population Density on USN Aircrew Capture

<table>
<thead>
<tr>
<th>Percent Distribution of Captures by Population Density</th>
<th>&lt; 130 Persons per Square Mile</th>
<th>130 Persons per Square Mile</th>
<th>520 Persons per Square Mile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent of Evaders in Each Area Captured Within 30 Minutes</td>
<td>23% (62 of 274 RPWs)</td>
<td>38% (104 of 274 RPWs)</td>
<td>39% (108 of 274 RPWs)</td>
</tr>
</tbody>
</table>

Figure 2-29: Air Force Evasion Times by Population Density (first 6 hours)
(Source: 7602 AIG, Section C, Figure 2)

77 7602 AIG, p. 19.
78 Every (1), Figure 13.
79 7602 AIG, Section C, Tables 1 through 3.
The characteristics of the parachute landing area were directly related to time-to-capture and survival. Although high trees, rocky terrain, and thick jungle vegetation were responsible for some parachute landing injuries, the thick vegetation served to give a survivor much better cover to avoid enemy detection. Conversely, if the survivor was severely injured and unable to communicate, it could also be responsible for his not being found by either friendly or enemy forces. The open, populated coastal areas generally resulted in a survivor's immediate capture (58 percent captured in the first 10 minutes and 84 percent captured within 30 minutes), whereas the heavy thick jungle areas and open ocean favored recovery. Open water landings, while resulting in a high rescue rate, also resulted in some severe parachute entanglement problems.

In any source that is referenced, the correlation between parachute landings in open terrain and high rates of capture appears to be very strong. An interesting exception is from the perspective of those that were actually captured. When interviewed after their release, only 5.4 percent of returned POWs cited "inadequate cover" as the primary reason for their evasion failure. Figure 2-30 shows aircrew status by parachute landing terrain.

Table 2-13 describes the impact of topography and foliage on rescue of USN aircrew in SEA. The statistics include only those aircrew known to be available for rescue following combat loss (i.e. instances of KIA and MIA are excluded).

<table>
<thead>
<tr>
<th>Terrain Type</th>
<th>% Recovered</th>
<th>% POW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open Ocean</td>
<td>96%</td>
<td>4%</td>
</tr>
<tr>
<td>In Shore, Open Areas, Lakes, Marshes, Rice Paddies, Populated Areas</td>
<td>15%</td>
<td>85%</td>
</tr>
<tr>
<td>Thick Jungle, Trees, Heavy Vegetation</td>
<td>91%</td>
<td>9%</td>
</tr>
</tbody>
</table>

Often, the jungle canopy was so thick in SEA that the survivor could not see the rescue aircraft even when it was in the immediate vicinity, and injuries often prevented the survivor from moving to an open area that would facilitate location and rescue. If a rescue was attempted in an area of rugged karst terrain with steep, sheer rock walls of high trees, it was often difficult to get the helicopter into a safe hover location. During retrieval, re-entanglement with the vegetation was a problem.

Interaction between terrain and the recovery vehicle itself was often the origin of problems. During the actual recovery, radios were practically useless due to the helicopter noise; requiring helicopter crews to rely almost completely on hand signals. Helicopter downwash was also a

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80 Every (2), p. 18.
81 Every (2), p. 18.
82 Every (2), p. 23.
problem both over land and over water (see Section 2.1.2.6 for an explanation of windblast, or Q-force). In the cases recoveries from the water, helicopter downwash “was often severe and hampered the recovery effort.” In some cases, as in the 1964 case of an attempted recovery by a relatively lightweight UH-1, the downwash doomed the recovery by actually drowning the rescuee. Overland the interference of helicopter downwash was no less severe. The force of the downwash would blow down trees and branches, knock survivors out of trees, and create a harsh environment beneath the helicopter during hoist recoveries.

![Figure 2-30: Aircrew Status by Parachute Landing Terrain](image)

DARKNESS AND WEATHER

In 1964 the HH-43F flew its first night mission picking up a Vietnamese A-1 pilot. Despite that early success, a viable night Combat Rescue capability never developed. In the early 1970s, an experimental night imaging system was installed on several HH-53s operating in SEA, but it was rarely used (although it was credited with enabling one night rescue in a remote area of Laos in December 1972). All in all, night efforts were rarely attempted and virtually always unsuccessful. Because so few night rescues were attempted, darkness is only rarely listed as a cause for mission failure. When darkness was listed as a reason for mission failure, it was generally because a rescue attempt begun in the late afternoon had to be abandoned because of darkness before the aircrew was recovered.

Weather is cited as a causal factor in only 6 percent of cases where a rescue mission was launched and the S/E was subsequently captured. Poor visibility and low ceilings in the terminal

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85 Tilford, p. 43.
86 Tilford, p. 61.
87 Tilford, p. 72.
area were typical of the weather that was described as contributing to rescue failure.\textsuperscript{88} While this data may be of interest, it must be remembered that the “causes of failure,” and other information from the 7602 Air Intelligence Group (AIG) source, are based on the opinion of the individual that was captured and not the crews attempting the recovery.

Figures 2-31 and 2-32 show the problems complicating successful rescues in SEA for both the USAF and USN.
Figure 2-31: Problems Complicating Successful Rescues in SEA- AF Experience
(Source: Directorate of Aerospace Safety, Section L)

Figure 2-32: Problems Complicating Successful Rescues in SEA- Navy Experience
(Source: Every [4], p. 26)
2.1.8.2 Threat

A study of US aircrew taken prisoner in SEA concluded that "the principal cause for failure to be rescued or evade was the immediacy of capture or the proximity of enemy forces." In 30.3 percent of USAF POW cases, a rescue effort was not even attempted because the shootdown occurred in a high threat area that prohibited any realistic chance of successful recovery. In those cases, it is doubtful that any improvement in rescue reaction time could have changed the outcome. Figure 2-33 shows that for cases where rescues were unsuccessfully attempted, enemy proximity was considered as the primary cause of mission failure in about 80 percent of those cases.

2.1.8.3 Time From Emergency to Ejection

Ejections initiated immediately after being hit decreased that aircrew's chances of successful rescue in several ways. First, it caused ejection in an area of known enemy activity; second, the immediacy of the event often led to a poor posture in the ejection seat, causing injuries that hampered evasion; third, it resulted in ejection at higher airspeeds, causing more severe (often debilitating) flail injuries; and fourth, it often prevented communication with wingmen or rescue forces before ejection (of those aircrew that became POWs, 47 percent were unable to transmit prior to ejection).

The immediacy of aircraft kill is directly related to the country of hit and, by extension, threat level. For example, in NVN 63 percent of all aircraft lost flew more than 5 miles after hit; the corresponding percentages for SVN and Laos are only 32 percent and 46 percent, respectively. It appears that the pilot's willingness to remain with his severely damaged aircraft is strongly dependent on the geographical area in which he is hit. Because of the threat in NVN, pilots tended to stay with their aircraft as long as possible to increase their chance of recovery. Rescue experience confirms the pilots' suspicions—pilot recovery rates were also directly related to country of hit, as well as distance flown after sustaining a lethal hit. For example, the recovery

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89 7602 AIG, p. vi.
90 7602 AIG, p. 4.
91 7602 AIG, Table 1.
92 Hewett, p. xii.
rate for pilots of aircraft hit in NVN who fly more than 5 miles after hit is triple the recovery rate for those who fly less than 5 miles. Of all USN aircrew forced to eject due to combat damage, only 47.5 percent were able to delay ejection more than 60 seconds after being hit (Table 2-14). Significantly, when only the subgroup of USN aircrew that were successfully rescued is examined, 87 percent of those aircrew had been able to delay their ejection beyond 60 seconds after being hit.

Table 2-14: Distribution of Ejection Delays After Hit (USN)

<table>
<thead>
<tr>
<th>% of Total</th>
<th>1-10 sec</th>
<th>11-20 sec</th>
<th>21-60 sec</th>
<th>1-10 min</th>
<th>10-30 min</th>
<th>30-60 min</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>24.7%</td>
<td>5.6%</td>
<td>22.2%</td>
<td>35.8%</td>
<td>9.9%</td>
<td>1.7%</td>
</tr>
</tbody>
</table>

Figure 2-34 vividly illustrates the association between delayed ejection and improved recovery rates. Of the USN aircrew losses represented in the figure, the mean time from emergency to ejection among those that were captured was 1 minute. In SEA, even if a Navy aircraft had time to get away from an inland target, the aircrew generally headed for the coast to reach the “feet wet” safe area. If they were unable to reach the safety of the open ocean, they were forced to eject over the more heavily populated coastal areas of NVN. Conversely, USAF aircraft would generally head back to bases in Thailand; and if forced to eject, the aircrew would eject over more densely vegetated portions of NVN or Laos. In those cases, although the range and response time was increased for rescue forces, recovery rates were higher. In NVN, a pilot who was able to travel at least 50 miles after being hit was more than seven times more likely to be recovered. Figure 2-35 shows the loss outcome by country and distance traveled after hit.

<table>
<thead>
<tr>
<th>Aircraft Type</th>
<th>Recovered Aircrew</th>
<th>POW</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-4</td>
<td>10.3</td>
<td>1</td>
</tr>
<tr>
<td>A-6</td>
<td>13.8</td>
<td>0.5</td>
</tr>
<tr>
<td>A-7</td>
<td>2.4</td>
<td>1</td>
</tr>
<tr>
<td>F-4</td>
<td>18.6</td>
<td>1.6</td>
</tr>
<tr>
<td>F-8</td>
<td>10.6</td>
<td>0.5</td>
</tr>
<tr>
<td>RA-5C</td>
<td>2.1</td>
<td>0.2</td>
</tr>
</tbody>
</table>

Figure 2-34: Mean Ejection Time for Navy Aircrew in NVN
(Source: Every [1], p. 7)

**References:**
- Hewett, p. xv.
- Every (2), p. 16.
Figure 2-35: Loss Outcome by Country and Distance Traveled After Hit
(Source: Hewett, Tables XXIX-XXXI)
Injuries were cited as the primary cause of evasion failure in 12.4 percent of USAF POW cases. More than 75 percent of all injured S/E that were captured were able to evade for only 60 minutes or less. In contrast, the population of uninjured evaders did not cross the 75 percent threshold until after twelve hours of evasion (Figure 2-37). Certainly, the absence of injuries plays a very significant role in an evader's ability to remain available for rescue.

Beyond being a factor in evasion success, S/E injuries also affected the rescue operation itself. A 1980 study of USN evaders confirmed what might seem intuitive—that "the time necessary to extract a survivor was almost directly related proportionate to the extent of the injuries to the survivor." Inevitably, what that meant was longer orbit and hover times required in the terminal area. Compounding the exposure of the helicopter during recovery of injured S/Es, when Pararescue specialists were deplaned to assist, it frequently meant that one or more of the helicopters guns were unmanned.

Those aircrew that were captured were more likely than those that were successfully rescued to have experienced a more severe aircraft emergency during the incident leading to the aircraft's loss. As described in Section 2.1.2.6, the POW group were forced to eject sooner, resulting in an overall mean ejection speed (for the POW group studied in Every [1] of 407 knots. This compares with an overall speed of 302 knots for aircrew that were successfully recovered in combat, and a speed of approximately 213 knots for non-combat ejections occurring during the same approximate time period.

The severity of aircraft emergency facing those who eventually became POWs is also suggested by their inability to control their aircraft. Among USN pilots studied, the recovered group was 4.5 times more likely to have a nose-up or straight-and-level attitude at the time of ejection than the POW group. Such catastrophic emergencies, and the consequent ejections, tended to produce more (and more severe) aircrew injuries.

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98 7602 AIG, p. 9.
99 Every (2), p. 22.
100 Every (1), p. 7.
101 Every (1), Table 4, p. 7.
Figure 2-36: Distribution of Injuries Among POW and Rescued Aircrew Groups (Source: Navy data and AF POW data in Every [1] p. 12; AF Recovered data in Hewett p. 43)

Figure 2-37: Influence on Injuries on Cumulative Capture Rates
(Source: 7602 AIG, Figure 1)
2.1.9 Recovery Force Losses

Rescue force planners assumed from the beginning that rescue force attrition would be high. Brigadier General Adriel Williams, Commander of the Air Rescue Service, in a letter to CSAF, Gen Curtis Lemay, cited Air Rescue Service Programming Plan 563, which estimated that the HH-43B/F force would suffer a 40 percent attrition rate in the first year of combat operation. Attrition rates matched the estimates, but not in the way that General Williams had probably anticipated—three HH-43Bs and two HH-43Fs were indeed damaged or destroyed, but they were lost on the ground during the Viet Cong attack at Bien Hoa.

In the end, more than 190 helicopters from all services were lost performing rescue in SEA, including 47 assigned to ARRS. 102 Of the 178 USAF rescue crewmembers aboard helicopters lost in combat, 29 percent were killed outright (see Table 2-15).

A review of H-3 damage incidents in SEA from 1965 to 1970 suggests that, in cases where the enemy inflicted combat damage, it resulted in mission termination (by destruction, forced landing, or mission abort) in about 40 percent of cases. In the remaining 60 percent of cases where H-3 combat damage was received, neither aircraft loss nor mission abort was reported. 104

Figure 2-38: Results of ARRS Rescue Helicopter Crew Losses in SEA
(Source: Granville, Table 15)

Table 2-15: AF Helicopter Losses (Aircraft and Crew) 103

<table>
<thead>
<tr>
<th>Aircraft</th>
<th>Aircraft Losses</th>
<th>Rescued</th>
<th>Missing</th>
<th>Killed</th>
<th>Captured</th>
</tr>
</thead>
<tbody>
<tr>
<td>CH-3</td>
<td>14</td>
<td>40</td>
<td>3</td>
<td>9</td>
<td>3</td>
</tr>
<tr>
<td>CH-53</td>
<td>2</td>
<td>6</td>
<td>0</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>HH-3</td>
<td>10</td>
<td>26</td>
<td>3</td>
<td>11</td>
<td>0</td>
</tr>
<tr>
<td>HH-43</td>
<td>10</td>
<td>24</td>
<td>0</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>HH-53</td>
<td>9</td>
<td>18</td>
<td>1</td>
<td>25</td>
<td>0</td>
</tr>
<tr>
<td>TOTAL</td>
<td>45</td>
<td>114</td>
<td>7</td>
<td>51</td>
<td>6</td>
</tr>
</tbody>
</table>

|          | 64.6% | 3.9%  | 28.7% | 3.4%  |

102 AF data from Granville, Table 15; Other service data from Air Combat Command, “Rescue and Recovery” worksheet. The 47 ARRS losses include two HU-16 airplanes. The USAF also lost 13 UH-1 helicopters in combat (although not necessarily while performing rescue missions). In the HU-16 incidents, 4 men were rescued, 7 MIA, 2 KIA, and none captured; the totals for the UH-1 incidents is 40 rescued, 0 MIA, 11 KIA, and none captured.
103 Granville, Table 15.
104 JTCG/ME, p. xii.
2.1.9.1 Recovery Force Losses by Mission Phase

Fixed-wing combat loss experience described in Section 2.1.2.4 is not dissimilar to the combat loss experience of "Rescue and Recovery" helicopters in SEA\textsuperscript{105}. Side-by-side comparison of the two categories is interesting—it shows that helicopters were no more likely to be lost than other combat aircraft (in terms of loss rate per 1000 sorties), and that the losses generally did not occur during the enroute phase, but were concentrated in the terminal area. For losses where the mission phase was reported, that data count 91 percent of "Rescue and Recovery" losses as occurring in the target (or terminal) area, compared with 83 percent of fixed-wing losses (see Figure 2-39). That comparison suggests that neither low altitude operations nor slow enroute airspeed alone are significant determinants of aircraft loss (even in the face of SEA’s ubiquitous and lethal AAA/automatic weapons threat environment). Rather it is the combination of forced exposure to the threat and the terminal/target area’s restricted or predictable flight profile that is likely the source such a significant increase in risk (the significance of this important concept is discussed in detail in Section 3.2.3).

Those data are consistent with 190 CH/HH-3 combat damage incidents examined by JTCG/ME. In that study, only 10.8 percent of incidents occurred during the "enroute" phase. The remaining 89.2 percent of incidents were attributed to mission phases associated with the terminal area ("hovering," "orbiting," "on ground," "landing," "taking off," "on water").\textsuperscript{106}

![Figure 2-39: Rescue Helicopter Losses by Mission Phase](Source: ACC XP/SAS Worksheet)

2.1.9.2 Recovery Force Losses by Threat System Type

Of the helicopters that served the French (prior to US involvement in Vietnam), virtually all combat damage was caused by small arms fire.\textsuperscript{107} As a result, the French took certain precautions including institution of a 3,000-foot minimum cruise altitude to keep helicopters well out of range of most rifle and machine gun fire. Use of “high-bird/low-bird” tactics in the terminal area (see Section 2.1.1.2) suggests that that tactic remained effective for the duration of the conflict. On the other hand, with the arrival of MANPADS in SEA, those tactics would have surely evolved had the war continued.

Improvements in rescue aircraft helped somewhat (for example, the use of titanium armor in vital engine and hydraulic areas improved the aircraft’s chances when it encountered small arms or light anti-aircraft fire) during the enroute portions of the mission. However, in a hover over a

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\textsuperscript{105} XP/SAS, “Rescue and Recovery” worksheet.
\textsuperscript{106} JTCG/ME, p. 102.
\textsuperscript{107} There is one documented case of helicopter loss during air refueling by a surprise attack by a North Vietnamese Mig fighter. That loss is not reflected in Figure 2-41.
survivor "it was still quite assailable." That susceptibility is vividly illustrated by the fact that more than 90 percent of rescue helicopter losses took place during terminal area operations that represented only a fraction of the total mission time.

![Figure 2-40: Causes of SEA Rescue Helicopter Combat Loss Incidents](Source: Air Combat Command, "Rescue and Recovery" worksheet)

### 2.1.9.3 Battle Damage to Recovery Vehicles

In terms of system vulnerability, the XP-SAS data shows that, among all rescue aircraft types, the aircrew themselves were the most vulnerable system, cited in 66 percent of incidents leading to loss of the rescue aircraft (see Figure 2-41). Engines and fuel systems were the next most vulnerable systems, receiving damage in 24 percent and 18 percent of cases, respectively.

A JTCG/ME review of H-3 systems damaged by enemy fire from 1965 to 1970 showed that for H-3 variants in SEA, the overall probability of kill per hit (Pk/h) was 0.021. When forced landings kills are included in the total, Pk/h = 0.036. One noteworthy finding of the study was that the average number of hits per incident was 3.8—nearly twice the number of hits per incident reported in previous studies on transport and armed escort helicopters. More than 90 percent of those hits took place when the helicopter was moving at less than 75 knots, and the most frequent listed phase of flight when hit was "hovering." While hovering, the average number of hits per incident was 5.5. The main rotor system was involved in the greatest number of damage incidents, and suffered the second highest number of actual hits, although damage to the main rotor system resulted in "relatively few" adverse reactions. The JTCG/ME data also gives an indication the impact of battle damage on mission performance (Figure 2-42).

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108 Tilford, p. 92.
109 JTCG/ME, p. xii.
110 JTCG/ME, p. ix. The average for HH-53s (operating mostly in NVN) was 7.5 hits per incident.
111 JTCG/ME, p. 22
Figure 2-41: Systems Damaged in Rescue Helicopter Combat Loss Incidents
(Source: Air Combat Command, XP-SAS “Rescue and Recovery” worksheet)

Figure 2-42: Impact of Combat Damage on CH/HH-3 Missions
(Source: JTCG/ME, p. xii)
Combat Experience at Koh Tang

On May 12, 1975, the American-registered cargo ship *Mayaguez* was taken at sea by Cambodian naval forces, and the ship's crew was brought ashore and held on Koh Tang Island. US reaction included a plan to land up to 600 US Marines on Koh Tang to recover the crew, setting into motion a remarkable series of events that is as sensational as it is instructive. Although it was not a Combat Rescue mission of the type described elsewhere in this report, a review of certain operational aspects is germane to understanding helicopter risk and the effectiveness of certain risk-reduction measures.

Although a detailed description of the entire battle on Koh Tang Island is beyond the scope of this report, one must know that the insertion of the Marines into various landing zones (LZ), and their subsequent extraction was in the face of significant enemy opposition. In that environment, Koh Tang Island is particularly useful due to the simultaneous employment of Combat Rescue and Special Operations helicopters with different combinations of armor, armament, training, fixed-wing support, and vulnerability reduction systems. In an excellent analysis of the battle, Jeffrey Eggers’ “Analysis of Helicopter Operations in the Battle of Koh Tang” looked at each of those variables to assess their impact on helicopter mission success and survivability.

For helicopter operations in contested areas, Eggers identified significant operational value in the use of dedicated ground attack assets to reduce enemy “anti-helicopter” defenses before commencing terminal area operations. Consistent with helicopter loss-rate trends in the terminal area, Eggers also found significant tactical value in coordinated defense suppression during the terminal area operation, and for RVs equipped with armor and vulnerability reduction features.

**ARMORED VS. UNARMORED HELICOPTERS**

Twenty-seven helicopter runs were made on the island of Koh Tang during the one-day battle. Of those runs, eighteen were by armored HH-53s (40th ARRS), and nine were by unarmored CH-53s (21st SOS). It should also be noted that the armored aircraft were also equipped with an additional machine gun employed from the HH-53’s aft ramp. Of the eighteen armored passes, there were no helicopter losses. Fourteen of the eighteen passes (78 percent) left the helicopter in a mission capable status, and four resulted in successful recovery of the helicopter but in an “unusable” status. Of the nine unarmored passes, three aircraft were lost, three remained mission capable, and three were recovered but unusable. Using those criteria, experience on Koh Tang Island suggests a strong advantage to the armor and armament available on the HH-53s.

**DEFENSE SUPPRESSION IN THE LANDING ZONE**

Although the data were insufficient to separately assess the effectiveness of defense suppression activity *before* and *during* the terminal area operations, Eggers suggests that the data “strongly support” the conclusion that the combination of LZ preparation and suppression during the terminal area operation greatly helped the helicopters in terms of both survivability and mission.

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112 In the case of the Battle for Koh Tang, the vulnerability reduction feature assessed was fire suppressant foam in external fuel tanks. While the example is specific, the concepts certainly apply to vulnerability reduction measures in general.
success. It should be noted that the effectiveness of defense-suppression activity was influenced by the helicopter crew’s ability to anticipate, understand, and (at times) direct that activity. Of the forces at Koh Tang, the 41st ARRS crews were experienced in those operations while the Special Operators, because of their different employment concept, were not.

Of the twenty-seven helicopter attempts to reach an LZ on Koh Tang, fourteen were performed with fixed-wing defense suppression support. Of those fourteen attempts, twelve (86 percent) resulted in aircraft that remained mission capable, two aircraft (14 percent) were recovered unusable, and none were lost. The results of the thirteen runs that did not have coordinated defense suppression available, five (38 percent) yielded mission capable aircraft, five resulted in a helicopter that was recovered unusable, and three helicopters (23%) were lost.

In the end, experience at Koh Tang, while not a “classic” Combat Rescue mission, seems a microcosm for the general Combat Rescue experience in SEA. It shows that integration and training with fixed-wing support assets matters, and that armoring aircrew stations and critical flight components significantly impacts both mission success and helicopter survivability.

For the purpose of his analysis, Eggers defines Mission Success as whether or not a run on an LZ resulted in successful insertion/extraction of Marines in the LZ.